Panels

Chair
Kathryn Saunders
ThinkTech

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Banff Centre for the Arts

Isaac Kerlow
The Walt Disney Company

Bill Kroyer
Rhythm & Hues Studios

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Cinesite Visual Effects

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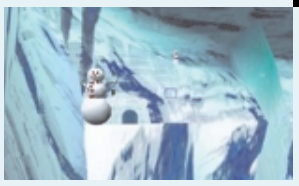
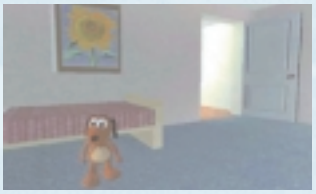


"You better think it out... Our lungs were meant to shout.
Say what you feel, yell out what's real...
Even though it may not bring mass appeal.
Your opinion is yours, mine is mine...
If you don't like what I'm sayin' fine."
– Ice T

SIGGRAPH 2001 Panels were deliberately selected to generate more noise than ever by focusing intense expertise on the most critical questions and controversies in computer graphics and interactive techniques. But the jury's long-range goal extended far beyond the heated debate of the moment. Our hope is that everyone who attended a Panels session, and everyone who reads these panel summaries, will help refine a very broad range of strong opinions and emotional positions into clarity, insight, and provocative visions of the future.

The panelists and the jury are simply facilitators and thought provokers. The Panels sessions and their outcomes belong to all SIGGRAPH 2001 attendees and the entire computer graphics community. It was a great honor, and a fascinating challenge, to help select topics, panelists, and technologies for this extremely diverse field.

In fact, this year's Panels submissions proposed the most extraordinarily diverse range of topics in SIGGRAPH history, from intellectual property rights for digital content to virtual-reality art, video-game design, Internet-connected applicances, new media and human cultures, reality modeling, non-linear animation, interactive entertainment on instant messaging devices, digital cinema, astronauts as artists, and how computer games affect digital visualization.



We also organized an amazing series of Special Sessions, all of which are documented in this section of the Conference Abstracts & Applications. One explained how Stanley Kubrick's totally analog "2001" inspired today's digital technologies in film and video. A Guided Tour of the New Silicon Senses featured transcontinental control of a robotic arm by a living creature, virtual retinal displays, Web-delivered smells and tastes, and advanced haptics. In Virtual Stars, digital artists revealed how they create digital actors. And in Masters of the Game, the world's leading game producers demonstrated and explained their award-winning work.

SIGGRAPH 2001 Panels and Special Sessions also featured real-time audience interaction via wireless Web access.

I am deeply grateful to the exceptional volunteer members of the Panels Jury, who devoted many, many hours of study, evaluation, research, discussion, debate, decision making, and coordination. Without their dedication and intelligence, SIGGRAPH 2001 Panels would never have been possible. Many thanks also to my wonderful subcommittee members whose perseverance and ingenuity helped produce some spectacular sessions, and to the entire 2001 committee for their support and guidance.

Kathryn Saunders
ThinkTech
SIGGRAPH 2001 Panels Chair

Video Game Play and Design: Procedural Directions

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Dominic Mallinson
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Janet Murray
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Bill Swartout
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Procedural simulation is an opportunity to revolutionize the way games are played and produced. Game-play design has relied on traditional models and has been constrained by old hardware design. New consoles will allow for procedural simulation and a "drama-on-the-fly" that no other form of entertainment is capable of. It will allow game consoles to reach their true artistic potential. For the developer, procedural simulation will offer a lighter, more versatile library of assets. The payoff will be twofold: a new, unique art form and a more cost-effective method of recreating intelligence, behavior, physics, and modeled environments.

This panel presents a snapshot of the current state of procedural simulation and the potential that it offers for game play and game design in light of advances in hardware design.

Video and computer games have come a long way from their simple beginnings in the arcades. PacMan, Space Invaders, and Donkey Kong made a fortune on simple colorful game play. As consoles have evolved, game development has become incredibly complex, exceeded only by the consumer's expectations for a higher level of game art and game play. Developers, keenly aware of consumers' expectations and stiff market competition, are spending record amounts of time and money on game development. There is no relief in sight, as manufacturers plan for more highly sophisticated consoles and shorter development times between successive versions.

Despite the pressure, game developers continue to rely on labor-intensive traditional methods (polygonal models, texture maps, and forward kinematics). It's no wonder that the cost of developing new games has risen from $1 million per title to more than $6 million. Production schedules have gone from one year to 2.5 years. Profitability is more uncertain.

The greatest relief for game developers will come in the form of procedural simulation. Creation of rule-based worlds to recreate intelligence, behavior, physics, and modeling could take the place of painstakingly modeled, animated worlds composed of thousands of human-engineered and painted polygons. The greatest advances may come in the type of game play that procedural simulation may allow. So far, game developers have used other art forms, particularly film, as a template for game play. This easy route does not necessarily allow for the computer or console to mature into its own unique art form. Groundbreaking game play development takes time and ingenuity, but it's potentially the greatest windfall for video game and hardware developers. It's already clear that games have piqued consumer interest much more than films. One look at box-office revenues versus game revenues is proof enough. Developers will need to satisfy that interest if they wish to unlock an even larger revenue flow.

Traditional Notions of Procedural Simulation

Specific areas of traditional procedural simulations include:

Intelligence
Recreating the inner workings of the human brain has long been a goal of science. Perhaps it's the $8-billion game industry that will lead to the greatest innovations, much like feature film was the catalyst for realistic modeling and simulations.

Behavior
So far, there is only as much behavior as can be animated using inverse and forward kinematics. The downside to this is that motion and animation are limited to the movement an animator gives a character. What needs to be explored is a universe where the entire range of body motion is written into the character, and intelligent agents within the game choose the proper motions for any given time and situation. The range of possibilities for game play then becomes infinite.

Speech
Interactive speech is probably the most underdeveloped aspect of gameplay. Pre-canned color commentary gives sports their sense of realism. Introduction of fresh, spontaneous commentary will give gamers a unique experience. Sadly enough, even simple speech communication between players has not been developed, although modems are standard on PCs and the new consoles include ports for broadband access.

Physics
Some of the greatest advances in procedural simulation are represented by depictions of real physics. Although they do not represent game play, they allow the audience to settle into a real world in which the game play can unfold. Depictions of moving water, collateral damage, and plumes of smoke add to the game's ambience. The consumer has seen what computer graphics are capable of producing with procedural effects in feature film. Their question is simple: "Why can't my console do that?"

Modeling
A healthy chunk of game production schedules, and the CD on which the game is distributed, is devoted to modeling and models. Modeling of environments, props, and characters is due for a procedural-simulation overhaul. Creation of entire cities and environments using procedural algorithms is potentially the greatest enhancement. The weight of polygons and texture maps is shifted to a lighter combination of lines of code and an infinite number of possibilities.

Procedural Simulation and Game play

The biggest challenge to researchers in AI is creating fresh, spontaneous gameplay. Hard assets provide limited possibilities in gaming. With procedural simulation, developers could create more malleable assets programmed with a multitude of possibilities, which will allow for more spontaneous game play. Why not create spontaneous drama-on-the-fly? What keeps us from creating a five-act structure on the fly so that games become a roller coaster ride with dips and climaxes like feature films? More importantly, procedural simulation may play its greatest role in creating unique gaming experiences rather than just mimicking other forms of media and storytelling.

George Suhayda
A graduate of Clemson University and Yale School of Drama, George Suhayda joined Sony Pictures Imageworks in 1998 and has worked on "Contact," "Snow Falling On Cedars," "Sphere," "City Of Angels," and "What Planet Are You From?" Currently he is visual effects art director on "Stuart Little 2" and working on game development for Sony's PlayStation 2.

Tom Hershey

The advent of procedural techniques in videogame design has, and will certainly continue to have, monumental impact on the gaming experience that players enjoy. This impact is multifaceted: ranging from "nuts and bolts" advantages in hardware resource management to influencing the way that game designers approach narrative structure and character/environment interaction.

On a resource management level, procedural approaches optimize storage space and computational capacity, and basically allow more content to be packed into a game. Animations appear more organic than those created by transitioning between pre-calculated, pre-rendered poses, and the computing cycles and storage resources required for procedural-based animation are dramatically lower than those required by traditional methods.

On a higher level, procedure-driven interactions between characters and environments can and will continue to move us toward the realization of our classic vision of AI. To date, players are conditioned to expect a high level of predictability and repeatability in game play. Monsters are triggered to attack when the player enters a room. Guards follow a set search pattern. Shoot a bazooka at a static wall and generally nothing happens. But with a modest amount of procedural "hooks" embedded in the design of the characters and their environments, the game play takes on a radically realistic feel. Adversaries can interact with one another and behave in a more unpredictable, organic way. Environment becomes a major factor: an iron door is harder than a wood one, a stone wall is impervious to a tank, but a brick wall can be broken down. It's clear that in procedural simulation of this type, a little goes a very long way towards fulfilling our perceptions of realism, and we are in the very early stages of what can be achieved.

A graduate of MIT, Tom Hershey worked as a programmer specializing in graphics applications for PCs. In 1988, he joined Columbia Pictures and worked for four years as director of production administration, helping to oversee production of feature films. He now leads Imageworks' movement into content development for Sony's PlayStation 2.

Dominic Mallinson

Procedural techniques offer many advantages for interactive computer entertainment. The ability to parametrically describe objects offers a richer variety of graphics and conserves system resources such as memory and memory bandwidth. From a production standpoint, procedural techniques can reduce the amount of manual content creation and consequently offer the possibility of lower development costs. For truly interactive 3D worlds, pre-calculated animations cannot be used. They are too constraining and costly. In these situations, physical simulation must be used to create the best experience. To populate these simulated environments, we need autonomous characters with their own behaviors and decision-making processes.

The state of the art is only just touching the surface of this procedural potential. The latest generation of game consoles such as PS2 enable these technologies, and I am certain that we will see them used with increasing skill to produce more compelling entertainment over the next few years. A glimpse into the future reveals whole worlds described not in terms of polygons, but in terms of their features. Artists may create a terrain by identifying peaks, ridges, rivers, and oceans, and the algorithms will fill in the rich detail of mountains, valleys, and coastlines. When two football players collide, the resulting falls and acrobatics will be different every time and not an inappropriate motion capture. Finally, the most challenging future will be when the player is not sure if the character he is playing against is a human or a computer simulation.

After graduating in computer science from the University of Durham, Dominic Mallinson worked at Microsoft on their first C++ compiler. He returned to the UK to work for Pilkington Glass on CAD and factory automation, then joined Psygnosis and remained there for seven years, during which time Sony acquired the company and launched Sony PlayStation.

Janet Murray

Characters provide a good focus for thinking about what can be accomplished in game design using more powerful programming techniques. There is a rich history already of experimentation with characters who have some autonomous or spontaneous behaviors, including most notably, the work of AI researchers such as Joe Bates and Bruce Blumberg; Will Wright's recent game, The Sims; and the success of virtual pets like pf magic's Dogz and Catz series. As broadband technologies bring interactive entertainment into the home, the popularity of such creatures may increase, and they may be used as entry points into complex fictional worlds. One of the clear recent results of this work is the understanding that it is "believability" that is important rather than the elusive goal of actually modeling human (or even doggy) thought. Although researchers, led by Blumberg, have gotten very far with ethology (the science of animal behavior) as a structure for character

creation, the range of behaviors that can be produced this way can be less engaging to the interactor than simpler creations if the character cannot dramatize the full richness of its inner life. Similarly, it is possible to create the illusion of a rich inner life with very little modeling underneath. So the problem for designers is one of deciding what is worth modeling.

One way of thinking about this is to start with how the behavior is going to be elicited. For example, the Petz series used "props" like feeding bowls and pet combs and catnip to suggest satisfying dramatic scenarios to the interactor. The more ambitious we make our characters, the more latitude we allow in the virtual worlds, the more complex the design questions of eliciting the characters' behaviors and making them legible and dramatically compelling. The Sims is the most ambitious such undertaking to date, using a dramatic structure much like the 19th century bildungsroman (novel of education) to shape the action. My remarks focus on the challenges of creating expressive characters in a procedural simulation framework and suggest some ways in which designers can think about the problem, drawing in part on the lessons of the earliest work in this genre (long before the days of multimedia): Joe Weizenbaum's classic program, ELIZA.

Janet Murray is the author of *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* and the forthcoming *Inventing the Medium: A Principle-Based Approach to Interactive Design*, both from MIT Press. She is currently serving as a trustee of the American Film Institute and serves as a mentor in AFI's Exhanced TV Workshop. Before coming to the Georgia Institute of Technology in 1999, she led humanities computing projects at MIT, where she remains a distinguished contributing interactive designer in the Center for Educational Computing Initiatives. She holds a PhD in English from Harvard University. Her research has been sponsored by the Annenberg/CPB Project, the National Endowment for the Humanities, the Andrew W. Mellon Foundation, IBM, and Apple Computer. She lectures and consults widely on the future of television, interactive narrative, and curriculum development for interactive design.

Bill Swartout

Procedural simulation holds enormous promise for creating games and simulations that provide much richer and varied experiences than the games we create today. If behaviors are generated dynamically, instead of being pre-recorded, they can respond naturally to situations or circumstances that were not anticipated when a game was originally programmed. In principle, procedural simulation allows us to vary behavior in subtle ways that reflect small differences in circumstances, something that would be very expensive to do if all the behaviors had to be pre-recorded.

But there's a problem. In many cases, procedural approaches can not yet exhibit the required range of behavior in a natural and convincing way. For example, consider machine-generated speech. Most current text-to-speech systems sound very un-humanlike, and even the most natural-sounding are incapable of expressing the range of emotions such as stress, anger, or fear that can be expressed easily by a skilled actor. Thus we seem to be confronted with a dilemma: Either take the procedural approach and use a text-to-speech synthesizer, thereby gaining flexibility but giving up expressiveness; or pre-record a library of a lot of expressive speech fragments with the risk that the right line might not be available in the library when needed.

The way out of this quandary is to borrow from Hollywood, where filmmakers often take a hybrid approach to creating a movie. Recognizing that each technique has its own strengths and weaknesses, Hollywood artists select the most appropriate technique for a each element of an overall scene and then composite the results together to create a unified whole. For example, a single sequence in a film might include live action, models, and computer-generated images, all integrated seamlessly to create a unified view.

In a similar way, procedural simulation techniques can be integrated with conventional approaches if careful thought is given to how the techniques are integrated. Depending on the role they play in a simulation (and the requirements the storyline imposes on that role) some characters might use a procedural approach while the behaviors of others might be pre-specified. In this panel overview, I outline our experiences in using a hybrid approach to integrate procedural simulation into a highly immersive VR simulation we have been creating to train soldiers about decision-making in complex peacekeeping situations. Because no single approach is sufficient for the range of behaviors we wanted to simulate, we found it necessary to integrate multiple approaches.

Formerly director of the intelligent systems division at the University of Southern California's Information Sciences Institutes. Bill Swartout has served as an associate research professor for the past 10 years. He holds a PhD in computer science from MIT. His specific research interests in the area of artificial intelligence include: intelligent agents, knowledge-based systems, knowledge representation and acquisition, and natural language generation. He was elected in 1992 as a Fellow of the American Association of Artificial Intelligence (AAAI). He served as the Conference Committee Chair for the AAAI (1992-1994), as Program Co-Chair at the Third International Conference on Principles and Knowledge Representation and Reasoning (KR-92), and as Program Co-Chair at the National Conference of Artificial Intelligence (AAAI-90).

Cultural Mediation in New Media Spaces

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Steve Dietz
Walker Art Center

Charlotte Pöchhacker
[art.image]

Perttu Rastas
Kiasma Museum of
Contemporary Art

Warren Sack
University of California,
Berkeley

New media technology has given rise to new spaces of communication that require new concepts of culture and art. Some artists and computer scientists are trying to visualize large-scale conversation on the net. Museums, cultural archives, and companies face the challenge of managing their data bases. This requires adapting concepts of knowledge management and semantics.

Artists and gallery curators have adopted the virtual space as a new medium for their work. Art is reaching new audiences. Innovative curatorial concepts try to take into account the special conditions of the Web, such as connectivity and participation. Exhibitions on the Web are part of a communicative process that could define new relationships between artists, curators, and the audience. New forms of culture and creativity emerge through the intersection of real and virtual spaces. In this panel, artists and curators share their projects, such as stages that mix physical presence and virtual spaces.

Gabriele Blome
netzspannung.org is a next-generation Internet platform that extends the abilities of the art and technology communities, and offers a variety of services and media channels such as infospace, dataspace, and workspace. netzspannung.org members no longer rely on rigid structures of given network architecture, protocols, and data formats. Rather, they are free to set up distributed community engines tailored to their specific needs. Platform architecture supports easy flexibility from the database level to the user interface and enables user-defined forms of interaction. The member-defined modules are spread over the community network or stored on a member's machine, which is seamlessly integrated and becomes a virtual part of netzspannung.org. The distributed community engine enables networked artistic production and offers spaces for presentation, communication, and information within a dynamic context. netzspannung.org was founded by Monika Fleischmann and Wolfgang Strauss at MARS Exploratory Media Lab, Institute for Media Communication

Gabriele Blome was assistant curator at Zentrum für Kunst und Medientechnologie, Karlsruhe, from 1997 to 1999. In 2000, she joined the Exploratory Media Lab, Institute for Media Communication, of the GMD German National Research Center for Information Technology, where she is curator for netzspannung.org.

Steve Dietz
Even for online or virtual display, strategies acknowledging the convergence of Internet and physical space must be developed. How can the postion of artists, audience, and museums be defined in such hybrid media spaces? What are the new formats and strategies of curatorial work and cultural mediation in networked environments?

Steve Dietz is the founding director of new media initiatives at the Walker Art Center, where he is responsible for information systems as well curating and programming the online Gallery 9. He co-initiated the award-winning ArtsConnectEd collaboration with The Minneapolis Institute of Arts and initiated one of the earliest archive collections of net art: the Walker's Digital Arts Study Collection, including äda'web, Bowling Alley, and DissemiNET.

He has organized and curated new media exhibitions, including Beyond Interface: net art and Art on the Net (1988), Shock of the View: Artists, Audiences, and Museums in the Digital Age (1999), Digital Documentary: The Need to Know and the Urge to Show (1999), Cybermuseology for the Museo de Monterrey (1999), Art Entertainment Network (2000), Outsourcing Control? The Audience As Artist, Open Source Lounge, and the Bureau of Inverse Technology's BangBang for Medi@terra 2000. Telematic Connections: The Virtual Embrace in February 2001.

Monika Fleischmann and Wolfgang Strauss
Mixed reality means constructing a space by interlinking different layers of reality into a new spatial frequency. Generating this space means staging an experimental field for performative perceptions. The metaphor we use is that of a room filled with data, a space that is performed by networked bodies. The Mixed Reality Stage is an instrument for the human body and vice versa.

Mixed reality requires interfaces to the senses, enabling people to communicate via perceptional channels: hearing, seeing, touching, moving, thinking. It is inhabited by two types of presence: the performers' physical bodies in actual space and virtual bodies in space/time representations. This is illustrated by several examples realized at MARS Exploratory Media Lab: Carry On, i2TV, and Murmuring Fields. In Murmuring Fields, the camera vision system draws traces of human movement in virtual space. Two performers develop a choreographic sequence in a space filled with a virtual sound field: an interactive radio play on stage.

The technical architecture is based on a VRML plugin, the eMUSE (electronic Multi-User Stage Environment) system. eMUSE is a theatrer machine, a multi-user system combined with a camera-tracking system. The eMUSE plugin is available at the netzspannung.org. Monika Fleischmann and Wolfgang Strauss are research artists who studied visual arts, theater,

architecture, computer graphics, and visual communication. Since 1992, they have been artistic directors of the Institute for Media Communication, and since 1997, they have directed Media Art and Research Studies (MARS) at GMD, the German National Research Center for Information Technology in Sankt Augusti, Germany.

Their work has been exhibited at the Centre Pompidou and the Museum for Design, and presented at the Museum of Modern Art and conferences such as SIGGRAPH, Imagina, Art Futura, ISEA, and Ars Electronica. In 1992, their Home of the Brain received the Golden Nica for interactive art at Ars Electronica.

Charlotte Pöchhacker
The ongoing growth of a media/digital culture and the increasingly sophisticated possibilities of the Internet present challenging possibilities for new thought on design and new forms of expression in cultural communication and cultural practice. These new conditions for curating, viewing, and experiencing online content require a profound reconsideration of interdisciplinary collaboration, of the relation of curator, artist, and audience, and of future modes of producing and exhibiting art.

Aganist this background, artimage's Tactical Systems for a New Cultural Practice explores visual, navigational, and technological innovations, and their potential for changing and expanding esthetic experience. The project is a testing ground for concepts that use the discursive and visual space of the Web to flatten distinctions between artist and curator and curator and audiences. Based on the notion that form affects content and comprehension, special attention is devoted to challenging Web design as a new cultural technique. Another important aspect of the project is testing and designing interactive spaces to address and reach different publics (interfaces that allow for individual access and multiple viewpoints: polyperspectivity).

Charlotte Pöchhacker is founding director of artimage and artistic director of the Graz Biennial Media + Architecture (Austria). She has edited several books and catalogues on the interdependency of media, architecture, and society, and conducted extensive curatorial work in the fields of new media art and architecture.

Perttu Rastas
I want to challenge the notion of virtual space vs. digital space based on my daily work at a new museum, where we have learned that keeping up and running this so called virtual world requires very special and very expensive hardware structure and software knowledge management. Secondly, I want to underline how importnat it is for artists that we have still non-commercial media institutions like museums. Media artists are the most important group and community who can give democratic and humanistic simulation (as a model of possible futures) for the IT-based industrial world. Thirdly, I want to show possibilities for cooperative programs that involve culture institutions and corporations, using the cooperation between Kiasma and Nokia as a sponsorship model.

Perttu Rastas is senior media art curator of Kiasma, Museum of Contemporary Art. He is responsible for Kiasma's information systems and media art collections. He shares responsibility for media art performances and exhibitions and is involved in planning Kiasma's theatrical programming in film and video. He has also worked for KSL's media workshop (1985-1989) as a production editor and as director of operations for the Finnish Media Art Archives, AV-arkki (1989-1994). He has been responsible for planning and coordination of MuuMedia (International Media Art Festival, 1988-1995) and has worked as media art consultant for AVEK (Finnish Audiovisual Support Center).

Warren Sack
With networked computers, we can begin to imagine the advent of a truly global conversation and meaningful communications among thousands, millions, perhaps even billions of people. But what do these new public spaces look like, and how do they support many-to-many communication? How can we begin to concretely envision these new kinds of connections that link people and media together? I am interested in online public space and public discourse. To better understand and participate in these emergent spaces, I design software to summarize, visualize, and navigate what I call very-large-scale conversations (VLSCs) like those conducted on Usenet and large mailing lists or bulletin boards. In this panel, I demo my Conversation Map system, which can graphically summarize the large volumes of email that constitute most contemporary VLSCs. It is my hope that Conversation Map is a first step toward a set of tools that will provide the means to navigate the social and linguistic connections engendered by the new media spaces of the Internet.

Warren Sack is a software designer and media theorist. Prior to joining the faculty at the University of California, Berkeley in the fall of 2000, he was a research scientist at the MIT Media Laboratory and a member of the Interrogative Design Group at the MIT Center for Advanced Visual Studies. His research interests include computer-mediated communication, online communities, architecture and design for online spaces, social networks, computational linguistics, and media studies. He designs software for navigation, summarization, and visualization of online, public space, and public discourse.

Size Matters: Digital Cinema Distribution

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Digital cinema is gaining momentum, and it is becoming a more viable reality. Although there are technical and logistical hurdles to overcome in the implementation of this medium, it will have a profound effect in the way we acquire, create, distribute, and view filmed entertainment. Panelists with varied perspectives on the feasibility of moving digital cinema out to the public outline the status of this film-industry evolution. Society of Motion Picture and Television Engineers Fellow Charles Poynton guides the panelists as they explore topics ranging from how a nationwide digital cinema infrastructure is constructed to whether there is enough bandwidth available to support it. Panelists also speak to the image integrity and film quality issues involved in digital acquisition of filmed entertainment, and how this affects moviegoers.

Allen Daviau
Allen Daviau has five Oscar nominations and numerous awards to his credit. Raised in Los Angeles, he developed an early interest in photography and lighting, and launched his career during the 1960s shooting pre-MTV music videos for local record companies. From there, he segued into filming commercials and documentaries, and in 1968, he shot "Amblin" for a very young Stephen Spielberg, with whom he eventually reteamed on "E.T. The Extra Terrestrial." He is one of the world's preeminent cinematographers. His work includes "The Color Purple," "Avalon," "Empire of the Sun," and "Bugsy." For "Empire of the Sun," he won a British Academy Award and an ASC Outstanding Achievement Award. In addition to being a prolific traditional cinematographer, Daviau has experience with digital cinema acquisition.

James H. Korris
James H. Korris currently serves as executive director, CEO of the Entertainment Technology Center (www.etcenter.org) at the University of Southern California. A sponsored research unit of the School of Cinema-Television, the center recently opened its Digital Cinema Laboratory, a permanent testbed in the heart of Hollywood. A neutral forum for development of benchmarks in this emerging technology, ETC is committed to fostering development of enabling technology for production and distri-bution of all forms of entertainment content. He came to ETC with over 15 years experience in television and film development and production with Imagine Films Entertainment, MCA Television Group, Universal Television, and others. He is a member of the writers, branch of the Academy of Television Arts and Sciences and the Writers Guild of America.

Bob Lambert
Bob Lambert is corporate senior vice president, new technology and new media at The Walt Disney Company. He leads the group responsible for developing strategy and practice relating to conventional and digital production methods across Disney's diverse businesses. Among other initiatives, he was instrumental in the conversion of Disney's animation business to a hybrid of digital and conventional technologies, which won an Academy Sci-Tech award. He has been intimately involved in film, video, and digital techniques for acquisition, production, postproduction, restoration, and exhibition for the past 15 years, including the current deployment of a small number of digital cinema theatres worldwide.

Joshua Pines
Joshua Pines, digital photography scanning supervisor at Industrial Light + Magic, has overseen the company's film scanning department since 1990 and extensively researched and tested the merits of both traditional and digital cinema. He started his career teaching film courses at Cooper Union in New York City, where he earned his degree in electrical engineering. He started working in visual effects at MAGI in 1982 at the tail end of their work on "Tron". Prior to joining ILM, he also worked at R/Greenberg Associates, where he led the computer graphics division, and at Degraf/Wahrman in the film department. He has always thought that computers could be a useful tool in making better movies, and he still hopes that one day this may come true.

Allen Witters
Allen Witters, WAM!NET chief technology officer, leads the company's global network and technology operations, including research efforts in digital cinema production and distribution. He has been involved in technical consulting for the computer industry since 1975 and has broad experience in the invention, design, engineering, and implementation of digital media production and distribution networks. He currently operates the world's largest IP network designed specifically for media distribution and is involved in architecting the Navy and Marine Corps intranet, the largest US-government IT project in history. He has spoken extensively about digital cinema and digital distribution.

Monster, Inc
Courtesy of Pixar/Disney

Computer Games and Viz: If You Can't Beat Them, Join Them

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Avalanche Software

Motivation and Key Issues

Historically, the visualization community has been a driving force in high-end computer graphics innovation, fostering new technologies that gradually filtered down to the consumer market. However, in recent years, the financial growth of the computer games market has made it the driving force of consumer graphics. How do trends and advances in computer games impact the scientific and information visualization community? This panel addresses this issue by highlighting the following items:

- How are visualization displays and paradigms influenced by interactive user interfaces and visual metaphors of game design?
- Are 3D visual thinking and visualization hindered or enhanced by 3D computer games?
- To what extent are visualization and visual simulation requirements altered or affected by games-driven enhancements to major application programming interfaces (for example, Direct X and OpenGL)?
- How do short release cycles affect driver stability and completeness of driver implementations?
- Will a computer-games focus produce a lack of advanced rendering features that could stifle visualization research?
- Is there a conflict between acceptable levels of accuracy and quality for artifacts in game development versus scientific and information visualization?
- Will the rapid pace associated with computer-games development be compatible or in conflict with the requirements of the visualization community?
- Will the computer-games arena provide the funding and research to improve graphics performance and price for the computer graphics field in general and visualization specifically?[1]

Theresa-Marie Rhyne

Fundamentally, computer games are about play, and scientific and information visualizations are about knowledge. It is possible to learn about how communities develop from computer games like SimCity (www.simcity.com) and The Sims (www.thesims.com). It is also possible to find "joyful curiosity" in scientific or information visualization. Could it be said that application of visualization techniques to urban planning is an intellectualized version of SimCity? Perhaps one of the impacts computer games will have on people is to prepare them to use visualization, virtual reality, and visual simulation to examine scientific problems and local community concerns. Artistically, computer game designs are influencing visualization paradigms and facilitating 3D visual thinking. One challenge is to ensure that there is some scientific accuracy in the content of computer games. Given the recent focus on computer gaming consoles, there still needs to be functionality in computer graphics tools to support scientific and information data models. The rapid pace of computer games development needs the calm and quiet zone of scientific and information visualization to allow for steady progress of advanced rendering techniques. Perhaps there is a symbiotic relationship here.

Theresa-Marie Rhyne is an independent consultant in visualization and 3D computer graphics. From 1990 to 2000, she was a government contractor (initially for Unisys Corporation (1990-1992) and then for Lockheed Martin Technical Services (1993-2000)) at the US EPA Scientific Visualization Center, where she was the founding visualization expert. She has organized courses and panels for previous IEEE Visualization and ACM SIGGRAPH conferences. She was IEEE Visualization 1998 and 1999 co-chair and a director-at-large on the ACM SIGGRAPH Executive Committee from 1996 to 2000. Currently, she is the project director of ACM SIGGRAPH's outreach to the computer games community.

Peter K. Doenges

Rapid development of 3D computer games fuels rampant hardware and software innovation. 3D games are surpassing professional 3D graphics and real-time visual simulation in certain areas. Game 3D technical innovation might benefit scientific and information visualization, but the technology is wired for different objectives. Scientific visualization seeks system understanding and values discovery. It needs flexible interfaces and programming via stable APIs for basic insights into forests of data. It also needs accuracy in multivariate data, data scalability and CPU-graphics bandwidth, and inter-processor communication. 3D games and Vis Sim focus on challenging human performance with fast fixed-function rendering of virtual worlds and landscapes for vital human experiences. Commercial predominance of 3D PCs and consoles could strand scientific visualization without needed features.

Cross-pollination is attractive, but challenges exist for derivative products to serve scientific visualization. Recent 3D game hardware turns to micro-coded pixel shaders, procedural vertex geometry, high micro-polygon densities, animating very large meshes, 2D/3D texture for illumination and reflection, and multi-texturing for pixel pipelines and cascaded separable functions. Developers wonder if PC 3D can scale up in multiple CPUs and 3D boards, if adequate data accuracy, bandwidth relief, viable inter-processor software, and frame-buffer access were available. Such graphics clustering invites balancing system resources and synchronization. It's time to stimulate dialog about

what configuring "3D in the small" can do for scientific visualization, and how scientific visualization algorithms could adapt to new architecture. Pertinent lessons emerge from large-scale geographic visual simulation with PC 3D.

Peter K. Doenges earned a BSEE from the Rose-Hulman Institute of Technology and a MSEE from Syracuse University. He is vice president of strategic technology at Evans & Sutherland, where he has been responsible for IG hardware/software, modeling tools, radar/sensor simulation, driving dynamics, early ASIC work, systems engineering, marketing, engineering business, and R&D. He is involved in curved surface and procedural shader R&D and convergence of professional and game 3D technologies with OpenGL and DX. He is member of the IEEE Computer Society, ACM SIGGRAPH, Tau Beta Pi, NSIA/ADPA, Computer Graphics Pioneers, the IMAGE Society Board of Directors, and the RHIT Industrial Advisory Board. He represents Evans & Sutherland with the Web3D/VRML Consortium, participates in the OpenGL ARB, and chaired MPEG-4 Synthetic/Natural Hybrid Coding for streaming 3D. For over 30 years, he has worked in real-time visual simulation and 3D computer graphics. He began with the GE Electronics Laboratory in IG R&D, computer film animation for NASA's Space Shuttle, real-time hardware/software for shuttle simulation, and USAF ASUPT scene generators.

Chris Hecker
Since most of the other panelists are coming at this question from the scientific visualization side, I describe the situation from the games side. How does the games community see the scientific visualization community? What are the advanced features that we beg hardware vendors to implement, and how do those features overlap with features needed by the scientific visualization community? And, from a slightly different perspective, how do game developers use scientific visualization techniques during development (or even during the end-user's play experience), and what does this mean for the relationship between the communities?

Chris Hecker is technical director at definition six, inc., a small game development company working on high-end physics and graphics technologies. He has been on the advisory board for the Game Developers Conference for many years and is a regular speaker at the GDC, the annual SIGGRAPH conference, and other conferences. He was co-organizer of the SIGGRAPH 2000 Course on Games Research: The Science of Interactive Entertainment and moderated the SIGGRAPH 99 panel on How SIGGRAPH Research is Utilized in Games. A frequent contributor to Game Developer magazine, he was the technical columnist for the magazine for two years and is currently editor-at-large. He is also on the editorial board of the computer graphics research publication, The Journal of Graphics Tools.

William Hibbard
For many years, visualization users bought their graphics hardware from SGI, who built it for them. Now they buy their graphics hardware dirt cheap from NVIDIA and ATI, who build it for people who want to play computer games. So the visualization community has already been revolutionized by computer games.

Since the graphics vendors are building for the gamers, they don't listen to scientific visualization people. But it will work out alright in the long run, since graphics hardware will have to be abstract, programmable, and interoperable in order to serve the needs of gamers. That is, graphics APIs will have to abstract in order to make the wide variety of images that gamers need, so they will be able to make the images that scientific visualization people need. Graphics APIs will need to be programmable to attract a large community of game developers, so they will be programmable by scientific visualization people. And graphics APIs will need to be interoperable, in order to support multi-player games.

Networked computer games will be the medium of the 21st century in the way that movies and TV have been the media of the 20th. So in the short run the graphics market is in turmoil as vendors jockey for a bigger piece of this huge gaming pie, but in the long run the graphics hardware necessary to support gaming will be as stable and cheap as television. The era of special-purpose hardware is being replaced by the era of Toys-R-Us.

William Hibbard is a scientist at the Space Science and Engineering Center of the University of Wisconsin–Madison. He was principal investigator of the NASA grant that supported development of the Vis5D, Cave5D, and VisAD visualization systems. These systems are widely used to visualize numerical simulations of the Earth's atmosphere and oceans. He was an investigator of the Blanca Gigabit Testbed network, studying the use of high-speed wide-area networks for interactive visualization. He has been a member of the Program Committee of the IEEE Visualization Conferences since their inception in 1990. He also writes the VisFiles column in Computer Graphics, the SIGGRAPH newsletter.

Hanspeter Pfister
Without question, technical advances in computer graphics are driven by games and entertainment. Computer games are the "killer application" for 3D graphics, and they will play this role for the foreseeable future. Consequently, we have seen an unprecedented rise in graphics performance and features in the PC gaming market. Very soon, you will be able to buy a mid-range PC with a 1GHz CPU and about a gigapixel fillrate. Recent features of commodity graphics cards include multi-texturing, hardware transform and lighting, full-scene anti-aliasing, and bump mapping. Very soon, we will see hardware support for vertex blending, texture transformations, shadow mapping, and 3D textures.

I think this is great news for the scientific visualization community. However, I dare to raise a word of caution. Let's not forget that many advanced rendering features, such as a wide range of pixel and texture formats, are not available on PCs. Let's not forget that PCs suffer from vastly lower I/O performance and smaller memory capacity than high-end graphics workstations. Let's not forget that the extremely short release cycles of the commodity market lead to unstable and incomplete graphics drivers. And let's not forget that PC games are driving the future development of our graphics APIs. What will happen if OpenGL is not able to compete with Direct3D anymore? Will an API controlled by Microsoft fulfill the needs of high-end visualization? I believe the scientific visualization community has a responsibility to speak out. Microsoft, Intel, and other vendors will listen to a market that is projected to reach $US 13 billion in 2005. Maybe it is time to form an interest group for scientific visualization that addresses these issues.

Hanspeter Pfister is a research scientist at MERL - A Mitsubishi Electric Research Laboratory in Cambridge, Massachusetts. He is the chief architect of VolumePro, Mitsubishi Electric's real-time volume rendering system for PC-class computers. His research interests include computer graphics, scientific visualization, computer architecture, and VLSI design. He received his PhD in computer science in 1996 from the State University of New York at Stony Brook. In his doctoral research, he developed Cube-4, a scalable architecture for real-time volume rendering. He received his Dipl.-Ing. degree in electrical engineering from the Department of Electrical Engineering at the Swiss Federal Institute of Technology in 1991. He is a member of the ACM, IEEE, the IEEE Computer Society, and the Eurographics Association.

Nate Robins

Computer games are a powerful driving force in the consumer graphics market. They have brought much of the power from what is normally referred to as the "big iron" down to the consumer desktop. As the computer gaming industry continues to burgeon, more of the capabilities normally associated with high-end graphics hardware will trickle down to the average consumer. This is leading to the possible demise of many of the pioneer graphics vendors, including SGI and Evans & Sutherland. Fundamentally, however, the gaming industry is not an innovator in the graphics arena. It is a consumer. They need the high-end industries, such as visualization, to be the driving force in graphics technology. Because the games industry is driven by a market that has an extremely short product cycle, there isn't much time for innovation beyond proven techniques, many of which are in use (or were invented) by the visualization community today. The visualization community could benefit from watching the games industry and keeping them informed of new innovations that they'd like to see become mainstream. If you invent it, we'll make it popular.

Nate Robins works for Avalanche Software. He is not a very competent video game player, but he really likes the problems involved in making them. He received a bachelors degree from the University of Utah, where he worked with Chris Johnson in the scientific computing and imaging group on the "Big Iron" project. He has also worked for Parametric Technology Corporation, Evans & Sutherland, SGI, and Acclaim Entertainment.

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The Future of Color: Creativity and Technology

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Neil Robinson
Industrial Light + Magic

Beverly Wood
Deluxe Laboratories

Roger Deakins
As a cinematographer, Academy Award-nominated Roger Deakins, BSC, ASC, has demonstrated how less is more. His masterful use of color has repeatedly demonstrated the impact of subtle manipulations. Preferring to color with light instead of filters, he creates images that are often dynamic and broad while maintaining a precise emotional impact. Cinematographers such as Deakins work very hard to capture specific emotional details of a story on film. They have a great deal of experience in orchestrating a story using images that are sometimes bold and dramatic, and sometimes extremely subtle. They understand the capacity of their medium, and often test its limits.

It is important for humans to communicate, and technology can be used to further that communication. Skillful cinematography must be supported by equally talented digital artists and tools that are not limiting to either. Furthering understanding of the technology and the art helps everyone communicate better.

Roger Deakins started in still photography and documentaries. He attended the National Film and Television School in England, where he met director Michael Radford ("Il Postino," "1984"). The two worked on documentaries together in school, and when Radford made the transition to drama, Deakins followed. Deakins' first Academy Award nomination came in 1994 with "The Shawshank Redemption." Soon afterward, he won the ASC award. His impressive body of work includes: "Sid and Nancy," "Pascali's Island," "Barton Fink," "Dead Man Walking," "Fargo," "The Hurricane," and last year's "Thirteen Days" and "O Brother, Where Art Thou?"

Joshua Kolden
A number of new image-representation technologies have surfaced over the last couple of years. In particular, work by Paul Debevec and Greg Larson has shown that images can store incredible amounts of unutilized information. With minimal effort, these data can be extracted and utilized to great effect. Additionally, intelligently increasing the information that is captured can produce remarkably powerful high-dynamic-range images in many areas of computer graphics. High-dynamic-range images were used in the production of the Experience Music Project motion-based attraction to successfully integrate lighting on the world's first CG human face replacement. In addition to remarkably realistic 3D lighting capture, these new image representations illustrate opportunities to store and manipulate images in new ways.

As computer hardware becomes less expensive and digital storage becomes easier to afford, it is becoming possible to address the subtleties of filmmakers' color decisions. It becomes economically feasible not only to maintain the image integrity through the entire digital process, from scan to print, but also to provide new creative tools. This added ability is possible because of the more complete representation of color. In addition, digital artists will need a more discerning "eye" to keep in touch with demanding filmmakers and become familiar with new tools for color manipulation.

Joshua Kolden studied film production at Columbia College, Chicago in the late 1980s. He went on to study computer science at the University of Arkansas at Little Rock. At UALR, he was invited to teach masters-degree courses in computer graphics and help develop the interdisciplinary computer graphics program. Over the last 13 years, he has contributed to innovations in the field of visual effects and computer graphics. Most recently, he supervised groundbreaking effects and animation for the Experience Music Project. This work involved human face animation and high-dynamic-range lighting effects integrated into and indistinguishable from live photography. Currently, Kolden lives in Los Angeles, and consults for leading visual effects facilities.

Neil Robinson
With the ever-accelerating pace of hardware and software development, it is all but inevitable that digital technology will effect all areas of filmmaking. The development of a digital grading system is just another step toward the full digital cinematic experience. The line between post production and grading is rapidly blurring, and in the process many new creative tools are emerging. Very soon, it will be commonplace for all motion pictures to be finished as a digital master before generation of the required deliverable media. The impact on costs, speed, and creativity should not be underestimated!

There will be "teething" trouble along the way, because the technical challenges are large. Asset management, data storage, transport, and archiving all provide areas ripe for development, as the shear size of the dataset required is astonishingly large! Combining high-dynamic-range image capture, post production, distribution, and projection all in the digital realm, digital grading delivers a realistic end-to-end digital motion picture experience devoid of any photo-chemical processes. The potential enhancements to creative story telling are limited only by the imaginations of their users. As many of us know, this is truly a creative business. After all, telling the story is what it's all about.

Neil Robinson graduated with a bachelor of electrical engineering in 1999 and a master of science in data telecommunications in 1992, and remained at the University of Salford, England until 1997, researching advanced high-speed telecommunication networks. He then applied his skills to the development of the Cineon compositing system as a contract engineer at Cinesite

(Europe) Ltd, where he is now senior research engineer. He has been responsible for development of both 2D and 3D image processing tools, and motion picture VFX production pipelines at Cinesite (Europe). Notable career highlights include an award-winning video-to-film tool (now in use in four countries) and development of the image processing work flow for the Cinesite (Europe) Digital Lab. He has been involved with many motion picture and broadcast projects (credits include "Lost in Space" and "Animal Farm").

Beverly Wood
Photo-chemical processing techniques have been advancing over the past 20 years. New film stocks and the demand for high-impact images have propelled development of many interesting new technologies, such as Technicolor's ENR process, bleach bypass, and Deluxe's ACE. With the advent of movies such as "Seven," which made use of a sliver-retention process at Deluxe Labs for a few hundred release prints, the demand for these color-manipulation tools has increased.

Digital technology has yet to master even the basic color timing technology used in film laboratories, and yet few digital artists have had the opportunity to learn these techniques or understand their value to filmmakers and the audience. Because of this, there is a great deal of re-invention by talented people who recognize the limitations but do not understand how they have already been solved.

For many years, Beverly Wood has helped directors and cinematographers take advantage of and develop new tools for artistic expression. She is vice president of technical services and client relations at Deluxe Laboratories, where she consults with directors and cinematographers on the lab's high-tech services, including digital, and photo-chemical printing processes. Wood earned her masters degree in analytical chemistry from the University of Georgia. She worked for Kodak from 1980 to 1989 as a technical liaison with film labs, at Metrocolor Laboratories from 1989-1990 when MGM closed that facility, and as an assistant to the director for several made-for-cable movies. For the past eight years, she has been involved with special color-processing needs for such films as "Pleasantville," "Seven," "Sleepy Hollow," and "O Brother, Where Art Thou?"

Visualization, Semantics, and Aesthetics

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University of Calgary

Sara Diamond
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Victoria Interrante
University of Minnesota

Jason Lewis
Arts Alliance Laboratories

Joshua Portway
RealWorld

David Sless
Communication Research
Institute of Australia

Sha Xin-Wei
Georgia Institute of Technology

This panel brings together artists, designers, computer scientists, and language theorists whose work integrates different forms of linguistics, such as computational and mathematics, with designing both computational systems and art works.

Visualization represents processes as much as objects, which is contiguous with much of contemporary art. Art and computer code share a basic intent: expression. There is an intense pleasure in putting the unknown and the unknowable into language. And there is tension between computer code and design: code requires precision; art requires abstraction and manipulation.

As images, visualizations are powerful and often beautiful in their own right. Why do some evoke erotic delight, and others a sense of awe? If visualization makes data meaningful to humans, what role does aesthetics play in this process? Where do the aesthetics of visualization act back on current design and art making? Is there a relationship between information: pattern: meaning? Simulations are intended to look like an actual process or natural form. What happens when we abstract simulations and apply them to other semantic systems? If the process behind the visualization itself supplies the "real," then computer science and art share the need to work with structuralist languages, abstraction, and an aesthetics capable of feeling process, rather than representation.

As researchers in the fields of visualization, computational linguistics, simulation, aesthetics, visual arts, and sociology work together, what new forms of language, meaning, and interpretation arise from these collaborations? What language can we use to describe our practice? Topography and topology are two valuable words. Can patterns be recognized in emotional or meaningful ways? What is the gap between recognition and meaning? Can these collaborations bring us beyond aesthetics of space or narrative? In what ways? How can this new knowledge be applied to large-scale systems, such as the Internet, forestry, and astronomy? Can aesthetics make data meaningful to larger publics or user groups?

Sheelagh Carpendale
In our information-dominated society, the favoured modes of information presentation are shifting away from a primarily verbal emphasis toward incorporation of a variety of visual forms. Rapidly increasing amounts of our communications are visual, and this trend has been accelerating in recent years. A great many advantages have been attributed to the ability to create good visual representations. Card et al. have declared that we should consider the possibility that information visualization can aid thinking processes.[1]

Can we then create visualizations that enhance cognitive abilities? In response to this challenge, there is a growing body of visualization research that strives to create intuitive visualizations through, on the scientific side, incorporation of perceptual and cognitive principles and, on the artistic side, recognition of the importance of emphasis, distinctions, and impact. However, there is another side to this issue: no matter how intuitive these visualizations are, they have to be interpreted by a person.

As a society, we place a great deal of emphasis on educating our children to become verbally literate. With the growing trend toward visual communication, a better understanding of visualization and visual presentation in general is becoming essential. However, to a great extent our education system still ignores this trend. While our children spend approximately 12 years of their lives learning to become verbally literate, comparatively little time is devoted to developing visual literacy.

Sheelagh Carpendale joined the Department of Computer Science at the University of Calgary in October 1999 and is a recipient of the National Science and Engineering Research Council University Faculty Award. Her research focuses on information visualization, where she makes a distinction between creation of visual representations and their presentation. In presentation space, she is exploring the resilient elastic properties available in virtual presentation. In representation space, she is investigating the possibilities of increasing or at least varying the methods that provide people, rather than algorithms, expressive control for creation and manipulation of representations.

Victoria Interrante
Visualization research is concerned with design and implementation of methods for effectively communicating information through images. The crucial initial step in this effort is conceptualization of the representational methodology: how do we intend to portray a set of data so as to allow the critical information that it contains to be easily, accurately, and intuitively understood? The solution to this problem requires not only a thorough understanding of the needs of the application, in order to choose wisely what aspects or features of the data to show, but also a keen understanding of the processes of visual perception, combined with a healthy dose of creative inspiration, in order to choose wisely how to show it.

A fundamental philosophy that underlies much of my work in visualization design is that there is a science behind the art of effective visual communication that can provide objective reasons why certain pictorial representations of data can be expected to be more effective than others and theoretical guidance for knowing how to create images in which the most important aspects of the information can be most easily and accurately perceived. Although our understanding of the scientific principles that underlie the design of an effective visual representation is still in its infancy, and creating a visualization that works remains largely an art, one of my goals is to make explicit aspects of the intuition that a good designer accumulates from experience and training, and relies upon when translating ideas to images.

Victoria Interrante is a McKnight Land-Grant Professor in the Department of Computer Science and Engineering at the University of Minnesota and a recipient of the fiscal year 2000 Presidential Early Career Award for Scientists and Engineers. She received her PhD in 1996 from the University of North Carolina at Chapel Hill, where she studied under the joint direction of Henry Fuchs and Stephen Pizer. From 1996 to 1998, she worked as a staff scientist at ICASE, a non-profit research center operated by the Universities Space Research Association at NASA Langley. Her research focuses on application of insights from perceptual psychophysics, art, and illustration to design of more effective techniques for visualizing data.

Jason Lewis
First the Dadaists and then the Concrete Poets surfaced the semantics implicit in the aesthetics of written language. Typefaces are not neutral; layout is not simply rational or irrational. Throw text on-screen, give it the ability to move and interact with a user, and the active meaning-making inherent in the visible construction of letterforms becomes impossible to ignore. Now apply that to attempts to visualize large-scale conversations and one quickly finds that the creative and intellectual possibilities are not only infinitely fascinating, but also (potentially) dangerous over-active participants alongside the users themselves.

Jason Lewis brings 10 years' experience in a wide variety of research environments to bear on the question of how to enrich and extend the user's experience of digital media. He is a practicing artist, designer, and technology developer, and recently founded the Arts AllIance Laboratory in San Francisco. His work has appeared at Ars Electronica, ISEA, and the annual SIGGRAPH conference, and he currently has a piece, TextOrgan, on two-year display at the Ars Electronica Center. He has spoken at the Banff Centre for the Arts, the San Francisco Museum of Modern Art , and the UCLA Department of Design, and worked at Interval Research Corporation, the Institute for Research on Learning, Fitch, and USWest Advanced Technologies. He holds a BS and BA degree from Stanford University, and a MPhil from the Royal College of Art, London.

Joshua Portway
The RealWorld exhibition will take the form of a darkened room with a domed ceiling upon which a computer display will be projected, like a planetarium. Audiences will be immersed in a world of real-time stock market activity, represented as the night sky, full of stars that glow as trading takes place on particular stocks.

Like the complex visualisation systems used by investors and traders to analyse the market, the system abstracts the information to help us read patterns in the data. Each layer of abstraction distances us further from the actual people that the data represents, until our system comes full circle and a new layer of living creatures emerges within the data itself.

The project links the earliest theories, such as astrology, to the latest scientific visualization systems. It examines the urge to understand our environment; the desire to predict, recognize patterns, and impose structure; and the limits of this ambition. By exploring our desire to abstract and order our environment, the project will act as a focus for debate about how much control is possible over complex systems such as the natural environment or the economy. The project explores an important issue for the 21st century: systems that we have created, such as the economy, the latest computer systems, genetically modified organisms, or even ideas, can generate their own behaviour and eventually transcend their origins, and may already be more powerful than we can control.

Joshua Portway's first video game was published 17 years ago and became a best-seller in Britain. Since then he has produced work as an artist, games designer, and animator. His interactive installation work has been exhibited in the UK, the US, and Denmark, and his animation work (including videos for Peter Gabriel, MTV, and others) has been shown at festivals and on television worldwide. In 1991 he formed Flux Digital, an interactive media and broadcast animation production company, which he left to join RealWorld in 1995. At RealWorld he has been trying to map the strange territories between music and interactive media, and is currently developing some secret and wonderful interactive music technology, to be released "soon." His latest project, Black Shoals, was exhibited at the Tate Gallery, London, in 2001.

David Sless
I'm interested in the philosophy of communication: the nature of communication and how we think about it. Approaches to visualisation and aesthetics make assumptions about the nature of communication. Some of these assumptions are built into the programming languages we use. Programming languages have semantic and syntactic properties. The notions of semantics and syntactics derive from communication theory.

I suggest that as these notions are currently applied, they are deeply flawed and impose an unnecessary limitation on programming and other intellectual pursuits. Alongside semantics and syntactics, there is a third category: pragmatics. I have come to the view that syntactics and semantics are subcategories within pragmatics rather than categories in their own right. The implications of this view are far-reaching and may change the way we develop future programming languages. In this panel, I use some of our recent research to illustrate the types of visual aesthetic problems that lie beyond contemporary computing languages but which may be possible if we rethink how such languages are constructed.

David Sless is director of the Communication Research Institute of Australia. He graduated from Leeds University in 1965 with an honours degree in psychology and sociology. Fascinated by communication problems in ordinary life (such things as signage systems that confuse people and labels that people can't understand), he went on to do research into ways of improving communication. In 1975, he was awarded an MSc by Durham University for his research in this field. He was then invited to take up a lectureship at Flinders University in South Australia to continue his research and teaching in communication. The relevance of his research into practical everyday problems of communication has now been widely recognised.

Sha Xin-Wei
If the power of making a trace comes from fashioning matter in the space of the imaginary, then mathematical drawing, sketching, and tracing have peculiar power. How is it that with a few strokes we create and shape geometries of arbitrary dimension or entities that have infinite extent? The creative power of visualization comes from somewhere in between the topological and the geometric.

What is the geometric? Riemannian geometry, for example, offers enough metric and curvature structure to sustain a kinematic intuition with functional, even computable presentation. But topology sustains ways to work both rigorously and intuitively about notions such as continuity, openness, convergence, and connectedness without binding us to any Cartesian framework. Imagining visualization as a process rather than a static representation, focusing on spaces of mappings rather than particular geometric domains, may bring us to the cusp of meaningful gesture and show us a way into the creation of felt meaning.

Sha Xin-Wei was trained in mathematics at Harvard and Stanford Universities, then worked in the fields of scientific computation, mathematical modeling, and visualization of scientific data and geometric structures. Since 1995, he has extended his work to distributed media authoring systems and media theory, in a three-year workshop on interaction and computational media.

After obtaining an interdisciplinary PhD at Stanford on differential geometric performance and the technologies of writing (in mathematics, computer science, and the history and philosophy of science), he joined the faculty of the School of Literature, Communication, and Culture at the Georgia Institute of Technology. He is currently constructing fusion experiments that materialize as cultural artifacts with colleagues in the TGarden Consortium and the Hubbub urban speech-painting project.

Sara Diamond
Sara Diamond is artistic director of media and visual art at The Banff Centre for the Arts. She leads all research, residency, exhibition, and training in the field of new media, television, and visual art at this international artistic research and professional development centre. She is also adjunct professor in the Design Media Department at the University of California, Los Angeles. She is currently writer in residence at the University of Surrey.

Her research explores the relationships among performance, role playing, dialogues, and the capacity of technologies, in particular visualization technologies, to provide tools, meanings, and emotional experiences for users. Her own research, Code Zebra, is a multiyear project with collaborators in Brazil, the USA, Canada, the United Kingdom, and Australia, exploring dialogues between artists and scientists using live and virtual tools. She has published extensively and curated exhibitions around the world. She develops new media streams for The Banff Television Festival and other world-renowned events.

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:-o A Conversation About Interactive Entertainment Experiences on Instant Messaging Devices

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Panelists
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Tom Freeland
Cybiko, Inc.

Erin Lemon
Digital 4Sight

Neil Young
Electronic Arts Inc.

From mad texting that incites political revolutions to alien-fish swapping games, the usefulness, richness, and whimsy found in the world of instant messaging is often lost on North American audiences. This panel demystifies (and reasserts) the fun everyone is having in Asia, Europe, and, yes, in some pockets of North America with AIM, ICQ, and Messenger, and their cell phones, cybikos, PDAs, and devices that can easily fit into a jean-jacket pocket.

Ana Serrano
Ana Serrano is director of Bell h@bitat, the new media training facility at the Canadian Film Centre, a world-renowned film, television, and new media institute established by Norman Jewison. She oversees the strategic planning, programme design, and fiscal development of all of the centre's new media initiatives, including creation of interactive narrative prototypes through the centre's New Media Design Programme. She was formerly the first associate at Digital 4Sight, a think tank and consulting firm founded by Don Tapscott, where she developed new media products and produced the company's first knowledge management toolkit. Featured as one of MacLean Magazine's Top 100 Canadians To Watch in the year 2000, she has recently produced the Great Canadian Story Engine Project, an oral history Web site of personal Canadian stories.

She is a member of the boards of the Canadian Conference on the Arts, Women in Film and Television, the New Media Advisory Committee of the Canadian Film and Television Production Association, and the Muriel Cooper Prize Council at the Design Management Institute. She frequently speaks at new media and film festivals throughout the world about the emerging realm of interactive and networked digital storytelling.

Erin Lemon
Erin Lemon is a research analyst at Digital 4Sight, a research and consulting firm specializing in business-model innovation for the digital economy. Her background is in the history and impact of technology adoption, and her areas of expertise include the mobile Internet and telematics. She is currently working on a multi-year research program entitled The Hypernet Revolution: Business Model Innovation in the Mobile Economy, which examines the social and economic impact of pervasive and ubiquitous computing.

Kim Binsted
Kim Binsted is one of the leading authorities on artificial intelligence (AI) and human-computer interaction (HCI), particularly as they pertain to character and humour. Her dissertation, Machine Humour: An Implemented Model of Puns, earned her notice in the international media, and she has since been featured in magazines such as Wired and Interview, and on television shows such as the BBC's Tomorrow's World. Her many high-profile appearances include a panel on computational humour at Stanford University with Marvin Minsky, Douglas Hofstadter, and Steve Martin and being the plenary speaker at Computer-Human Interaction 2000.

In Japan, she was a researcher at the Kansai Advanced Research Center and at the Sony Computer Science Laboratories, where she worked on emotionally-responsive HCI. Past projects include BOKE (a Japanese pun generator), Byrne (an expressive talking-head football commentator), HyperMask (a wearable animated face for live performance), and Danger Hamster 2000 (an expressive character in an unpredictable environment). She has a PhD in AI from the University of Edinburgh and a BSc in physics from McGill University.

Neil Young
Neil Young, vice president and executive in charge of production at Electronic, is the creator and driving force behind "Majestic," to which he brings more than 10 years of successful interactive entertainment experience and knowledge. He began his career in the interactive entertainment industry in 1988, when he was a programmer and producer at Imagitec, a small British development company, where he worked on platform conversions for games developed by Electronic Arts, ORIGIN Systems, Microprose, and Mindscape. He joined the staff at Probe Software in 1990 as a senior producer, working on a wide variety of titles for Acclaim, Sega, Hudson, USGold, and Virgin Interactive.

In 1992, he moved to the United States and was promoted to vice president for product development at Virgin Interactive. Five years later, he was named vice president and general manager of ORIGIN Systems, a subsidiary of Electronic Arts, where he supervised the launch of the highly successful Ultima Online. In 1999, he assumed his current position at Electronic Arts, where he is currently creating next-generation interactive content for EA.com.

Tom Freeland
While studying information technology at the Rochester Institute of Technology, Tom Freeland founded and became president of the Information Student Technology Organization. He also pieced together a virtual reality system and developed multimedia for the hearing impaired. Soon afterward, he brought music to life for the hearing impaired when he created a software package that allows MIDI music to be seen in artful dynamic shapes and colors. He then pursued multimedia design and development, first at Xerox Corporation and then at KLS Studios, where he was the instrumental developer in a team that created a CD-ROM that won an international award from Grafis. As director of game design at Cybiko, Inc., he maintains an unofficial world record of releasing one game every day for the company's wireless computer.

Newton's Nightmare: Reality Meets Faux Physics

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New York University and University of Toronto

Reality – who needs it? Is computer graphics about building more and more accurate simulations of the real world, down to the last photon? Is computer graphics really hard physics dressed in Hollywood clothing? Or is reality, like, soooooo old fashioned? Is computer graphics now free from its shackles, free to create non-whatever realistic experiences, free to write its own laws, with no relation to reality? This panel sheds some light (real or imagined) on these complex questions.

Dinesh K. Pai
Computer graphics is indeed about reality, but reality as experienced by humans. We need models of reality but our needs are very different from, say, the needs of physics or engineering. I argue that:

1. New, creative applications in computer graphics need new types of models, but these still need to be rooted in reality, because human perceptual and cognitive systems evolved to cope with it. We need to model not only external physical systems, but also human systems that produce and consume the experience.

2. Traditional models of reality are based on the assumption that measuring the real world is a lot more expensive than simulating it. New and inexpensive sensors have changed the economics of measurement and hence of modeling, making radically different models possible.

3. All models of reality are wrong, but some are more wrong than others for a specific purpose.What matters is to clearly know the metric. Is interactive response more important for perception than accurate motion? Are we trying to convey the details of a real object on an e-commerce Web site, or are we trying to direct attention to the object's most important features?

Dinesh K. Pai, a professor of computer science at the University of British Columbia, received his PhD from Cornell University. His research interests span the areas of robotics, graphics, modeling, and simulation. His current interests are in interactive multimodal simulation of contact (including auditory and haptic displays) and acquiring multimodal models of everyday objects using automated measurement techniques.

Holly Rushmeier
Design applications where the image is not the end product but a means to predict what a physical design will look like require accurate simulation. Researchers have developed simulations of light transfer to compute the quantity of energy that would pass through each pixel. We can still develop better algorithms, but there are few major problems left in the simulation of light. There is no reason to consider quantum or relativistic effects. Our research challenges are now in psychophysics, understanding what features will have an impact on a human observer.

Many interesting effects have been developed by accident – by setting various parameters and seeing if the resulting image is pleasing. Our knowledge of how to simulate the physics of light gives us the ability to delibrately control rendering to create consistent, visually rich alternative environments. While talented artists have always done this with effort, we can now facilitate more experimentation. Rather than relying on accident, we should further exploit what we know about light and deliberately change the rules to provide powerful new tools.

Holly Rushmeier received her PhD degree in mechanical engineering from Cornell University and is now a research staff member at the IBM T.J. Watson Research Center. Her research interests include data visualization and realistic image synthesis.

Doug Roble
In the realm of visual effects, we are always trying to convince people to suspend their disbelief. Of course, there are the big effects (the asteroids and the spaceships and aliens), but audiences know that they aren't real, so digital artists can have fun and get away with non-real effects and graphics. When I reflect on the most gripping visual effects scenes, I think of small effects that fool me utterly: the cow getting hit by the car in "Oh Brother, Where Art Thou?" or Julia Roberts' car accident in "Erin Brockovich." These scenes are devastating in that computer graphics has been used to manipulate and simulate reality so well that you don't have to suspend disbelief. There was never a point where you disbelieved!

So, do we need to simulate reality? Of course! The more accurate the lighting, the fluid dynamics, the surface parameters, the modelling ... the more powerful an artist becomes. Just look at the trends in the effects industry: Years ago, particle systems were all the rage. Now every effects house is developing its own fluid dynamics package. For characters, an IK weighting system controlling a NURBS surface used to be good enough. Now we are all developing physically accurate bone/muscle/skin systems. Visual effects houses have all adopted computer-vision techniques to extract every last bit of information from the real world.

Can we mimic reality without accurately simulating it? Sure! That's what we've been doing for years, and you've seen the results on the movie screens. We need to continue to forge ahead with more detailed and accurate models so that the artists can produce the effects of the future.

Doug Roble is creative director of software at Digital Domain and Sketches and Applications Chair for SIGGRAPH 2002. He has been developing tools and doing research at Digital Domain since 1993. His computer vision system, "track," won a Technical

Achievement Award from the Academy of Motion Picture Arts and Sciences in 1998. He received his PhD in computer science from The Ohio State University in 1992.

Richard Szeliski
"Faux physics or no physics?" For many computer graphics applications, it is often sufficient to simply capture some real-world imagery, and then to manipulate it to get the desired effect. An early example of this was image morphing, where different video streams could be morphed or blended to get compelling transitions between different people or objects. More recently, image-based rendering has suggests that we can often approximate the 3D appearance of an object (and generate novel interactive views) by simply jumping (or interpolating) between different views. Current implementations of the "freeze frame" effect often do just that: jump between a densely spaced set of still images taken with cameras.

Of course, doing computer vision analysis (recovering the geometric side of the "physics") allows us to use fewer cameras or to get better interpolation results. Still images, however, are just a very narrow subset of what we want to synthesize in computer graphics. The temporal analog to image-based rendering is video-based rendering, where sample video clips can be manipulated to achieve novel synthetic video sequences. An early example of this was *video rewrite*, which manipulated (concatenated and blended) digitized lip motions to make a character say new speech. More recently, we have been working on *video textures*, which can synthesize realistic, novel, quasi-periodic motions (waterfalls, flames, swimming fish, talking heads) from sample video footage. Is this "data driven" or "machine learning" ("no-physics") approach the solution to everything? Obviously not.

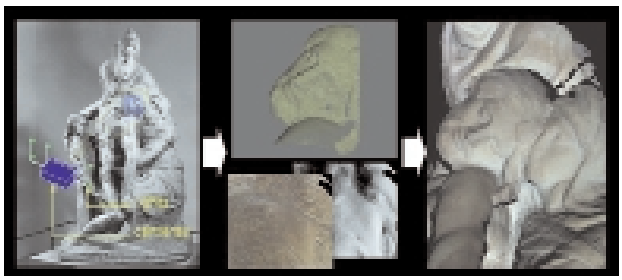
For many (most?) applications, we will get more mileage by trying to understand (and then simulate) the actual physics (geometry, photometry, dynamics, behavior) of the phenomena we are modeling. For example, recovery of BRDF from multiple images is currently one of the hot areas in image-based modeling. It's just that a complete model is often very hard to achieve, both because of our limited understanding, and because the inverse estimation problems are often ill-posed. Judicious knowledge of when to "fake" aspects of the physics will always remain one of the hallmarks of successful application of computer graphics to complex phenomena.

Richard Szeliski is a senior researcher in the Vision-Based Modeling Group at Microsoft Research, where he is pursuing research in 3D computer vision, video scene analysis, and image-based rendering. His current focus is on constructing photorealistic 3D scene models from multiple images and video. He received a PhD in computer science from Carnegie Mellon University in 1988, and he has been at Microsoft Research since 1995.

Demetri Terzopoulos
My holy grail is a "reality emulator" as compelling as the one portrayed in "The Matrix." Although a multisensory computational simulation with such incredible fidelity (never mind all the exhilarating weirdness!) remains elusive, the trend in computer graphics is clear. With Moore's law on our side, researchers and practitioners alike are eagerly pursuing what might be characterized as the "Taylor series approximation to reality." I, for one, have found it intellectually stimulating to help establish some crucial, low-order terms of this approximation, which now epitomize the prominent physics-based and biology-based (artificial life) paradigms in CG modeling and animation. The endeavor of systematically augmenting the realism of CG models continues to excite me.

However, I also believe that we should explore alternatives to simulation. It behooves us to exploit the special computational structure of the brain, which after all is the client, ideally through a direct brain-machine interface, of our provisionally mythical reality emulator. The brain learns to perceive the raw reality of nature in certain ways and not in others. In this context, recent CG techniques such as the NeuroAnimator (SIGGRAPH 98) are provocative. They suggest that it should be possible to create a new breed of emulation algorithms that, through observation of reality by computational structures analogous to those found in the brain, can learn to mimic a wide variety of natural phenomena (physical dynamics in the case of the NeuroAnimator) with sufficient fidelity to render all residual errors imperceptible.

Demetri Terzopoulos holds the Lucy and Henry Moses Professorship in the Sciences at New York University and is professor of computer science and mathematics at NYU's Courant Institute. He is currently on leave from the University of Toronto, where he is professor of computer science and professor of electrical and computer engineering. He received his PhD degree from the Massachusetts Institute of Technology. He was elected a fellow of the IEEE, a fellow of the Canadian Institute for Advanced Research, a Steacie Fellow of the Natural Sciences and Engineering Research Council of Canada, and a Killam Fellow of the Canada Council for the Arts. Among his many awards are computer graphics honors from Ars Electronica, NICOGRAPH, and the International Digital Media Foundation.



Real…(above)

…or not? (left)

VIPs: Virtually Invented People

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Ananova

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R.U.Sirius
Alternating Currents

Thomas Vetter
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Keith Waters
LifeFX

Since the early days of computer animation, researchers and artists have been fascinated by the digital grail of creating a life-like resemblance. Recent advances in technology have brought us closer to that reality and toward the possibility of creating credible and plausible digital human forms complete with physical, behavioral, and emotional capabilities.

Building compelling, realistic virtual people is technically challenging, drawing on many disciplines beyond computer graphics. As we move toward a generation of digital characters, we will be presented with new possibilities. Novel forms of personal interaction, as well as human-machine communication, will become viable, and the interactions will be familiar as well as intriguing.

However, what repercussions will they have on our social networks, our basic human needs, our belief systems? This panel presents the exciting new generation of VIPs exlores offer a glimpse into a what the future holds for the next generation of lifelike virtual humans, and discusses the social, entertainment, and psychological challenges that these technologies imply.Ananova, the world's first virtual news anchor (www.ananova. com), combines sophisticated real-time news and information systems with advanced instant animation techniques. The technical challenge for Ananova's creators was to engineer a fully animated virtual character capable of dealing with a vast range of dynamic content. Using XML as a basis for video scripts, the Ananova team gave the character the flexibility to respond differently to any given news item and to behave appropriately in many different situations.

On the Web, Ananova can be seen in the form of streaming video. However, this is only one of many incarnations of the character currently in development. Ananova's vision of the future is one in which users will have access to a fully interactive personal information assistant that can help them find their way through an increasingly information-rich world.

The Ananova service focuses on provision of personalized, real-time breaking news. It alerts users to the information they need to know, the instant it happens. Users tailor the Ananova service to their own interests by choosing subjects from a catalog of over 3,000 topics, which is growing daily. When news breaks in their chosen areas, Ananova contacts the user via the Web, email, SMS, voice, or personal WAP page.

Andrew Burgess
Andrew Burgess is responsible for software development, Internet systems and connectivity, Web site construction, and project management for Ananova. He joined PA New Media as head of operations in January 1998 and previously worked for CompuServe UK as technical director during its period of fastest growth. He has also held positions with British Telecom and Knight-Ridder Information Services in a variety of technical and consumer-interfacing roles.

Barbara Hayes-Roth
People are social animals. As children, we play with dolls and other anthropomorphic toys. As adults, we enjoy character-based films and stories, as well as the colorful characters who enrich our daily lives. Equally important, whether we are working, learning, or playing, we interact more easily, more effectively, and more happily when our interactive partners are distinctive, interesting, empathetic individuals who communicate with us through natural and familiar social channels. For these reasons, we believe that smart interactive characters will offer a uniquely effective and satisfying interface between people and a variety of electronic experiences.

To fulfill their promise, interactive characters will need to have virtual "minds" that are every bit as expressive as their virtual "bodies." Like great works of art (paintings, photographs, animations, theatrical, and cinematic performances), great interactive characters will create the appearance that personality, thought, feeling, and intention drive meaningful behaviors. However, unlike the players in these traditional art forms, Virtually Invented Persons (VIPs) will not be posed or scripted. Instead, they will be open and dynamic performers, more like improvisational actors or people in their natural interactions. Thus, great VIPs will need expressive graphical bodies capable of generating meaningful but unscripted gestures and facial expressions in real time. And they will need expressive minds to manifest personality, thought, feeling, and intention in real time, in order to drive and coordinate meaningful verbal and non-verbal behaviors.

Barbara Hayes-Roth is the founder and CEO of Extempo Systems, Inc., an innovator in smart interactive characters for online learning, customer relationship management, and interactive entertainment. She led development of Extempo's award-winning technology and products. She holds a patent for the System and Method of Directed Improvisation by Computer Characters and has several other patents pending. Previously, she directed research on interactive characters, intelligent agents, and human cognition at Stanford University, the Rand Corporation, and Bell Laboratories. She has published over 100 research articles and given many invited speeches in the US and abroad. She holds a PhD in cognitive psychology from the University of Michigan, and she is a fellow of the American Association for Artificial Intelligence.

R.U. Sirius
From a virtual pop star to a virtual president. William Gibson's "Idoru" is just one among several novels that imagines a world with virtual pop stars. How will virtual celebrities and (eventually) politicians impinge on our social reality and our perceptions of reality? What role does giving synthetic intelligence a face play in preparing us for a human society entertained, entranced, and governed by reasoning machines? And as we move into a world in which even the neighborhood plumber has a persona that's up for periodic reinvention, to what

extent will we attempt to virtualize ourselves? Will we get to lead many simultaneous lives? These entertaining and interesting questions have no answers, but they do provide us with abundant opportunity for imagining.

R.U. Sirius was editor-in-chief of the world's first technoculture magazine, Mondo 2000, from 1989-1993. Since then, he has authored several books including *The Cyberpunk Handbook and Design For Dying* (with Timothy Leary), and written hundreds of articles for periodicals including Time, Wired, Esquire, and Salon. He is currently editor-in-chief of Alternating Currents, a quarterly print journal, and chairman of The Revolution, a political party.

Thomas Vetter
The challenge of creating virtual persons has always been attractive to humans. With the rapid development of computer graphics, many new forms of synthespians are being developed or discussed. One direction of this research and thought is to create a virtual copy of a real, existing person, a copy that simulates not only visual appearance and voice, but also language, specific knowledge, and behavior.

The focus of research in the computer graphics group at Universität Freiburg is how to create a convincing visual copy of a person's face from a small number of photographs, perhaps even a single image, or from video material. Our goal is to create novel, photo-realistic images and motion sequences that were not part of the original material. The challenge is to understand the minimal requirements necessary to build a convincing computer graphic model of a person's face from images and to understand the perceptual sensitivity of human observers to the variability of an individual face.

Our approach is based on a method that we call a morphable model. It is a general, flexible 3D face model. In an analysis by synthesis loop, a given novel image can be reconstructed by the model. Coded or described in terms of the internal model parameters, a face in an image can be rotated, re-illuminated, and animated. Starting from state-of-the-art image modeling techniques, we explore future directions in automated techniques for manipulation of portraits.

Learning the appearance of faces from other example faces might be a paradigm that could be transferred to simulation of more complex phenomena, such as facial gesture or even behavior and language.

Thomas Vetter is head of the Computer Graphics Group at Universität Freiburg, Germany. He studied mathematics and physics at Universität of Ulm, where he did his PhD on neuronal signal processing. In 1991, he joined a group led by Tomaso Poggio at the Center for Biological and Computational Learning at the Massachusetts Institute of Technology, where he worked on visual object recognition and learning strategies for representations of object classes. In 1993, he joined the Max-Planck-Institute Biologie in Tübingen, Germany, where he started his work on models for analysis and synthesis of face images, which is still his main focus of research.

Keith Waters
The human face is the most expressive component of any Virtually Invented Person (VIP) so getting the face "right" is vital. The face has to be believable, especially if we are presented with a representation of a real person. In fact we are "wet wired" to interpret images of faces, which makes the task even harder, because even the subtlest incorrect movements are easily detectable. If it looks like a person, we expect it to behave like a person.

The goal of creating a synthetic representation that is indistinguishable from a real person has been the subject of much investigation over the last decade. Achieving this goal has been technically challenging. Not only does the physical representation of the face have to be accurate, but also the face has to move, talk, and act in a plausible fashion. Progress has been made in some key areas of facial synthesis, while other areas remain relatively unexplored. So what aspects of facial synthesis are easy, and what aspects are hard? What areas of investigation are required to bring life to VIPs? Understanding where some of these technical boundaries exist helps us build new and exciting artifacts.

Keith Waters is currently the senior technical officer of LifeFX. Prior to joining the company, he was a principal member of the technical staff at Compaq Computer Corporation's Cambridge Research Laboratory. While at Compaq, he studied novel forms of human computer interaction, including facial animation synthesis. He is co-author of a standard text in the field, Computer Facial Animation, and he has published numerous papers on the subject. While at Compaq, he was responsible for development of FaceWorks, a Windows-based multimedia authoring tool for synthetic faces. Prior to 1999, he was at Digital Equipment Corporation, where he developed DECface, a real-time synthetic face utilizing DECtalk, a software text-to-speech engine.

Kathryn Saunders
Kathryn Saunders is a founding partner of ThinkTech, a consulting firm that designs and develops location-based and e-based experience strategies. She has been actively involved with SIGGRAPH for many years. She is Panels Chair for 2001, and for SIGGRAPH 99, she chaired Emerging Technologies, where she developed and executed the Millennium Motel concept and curated several elements including the entry portal and Route 66.

Trained as an architect, she practiced architecture with two of Canada's leading design firms and has taught architecture at two Canadian universities. Prior to her current post, she was executive director of the Digital Media Institute and creative director, digital media, at the Royal Ontario Museum. At the museum, she developed MYTHICA, an educational entertainment destination that uses a profiling system, wireless technologies, and intelligent autonomous agents to deliver personalized information before, during, and after a visit, based on the visitor's behavior and aspirations. A recipient of many interactive media awards, she has consulted and lectured around the globe from North America to Saudi Arabia and Japan.

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Ivo Horvat
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Steven Markowski
Cinesite Visual Effects

Sande Scoredos
Sony Pictures Imageworks

Tom Sito
University of Southern California

Derek Chan
When I first entered computer science, one of my goals was to create software that "even my mother could use." Now that I've been working at DreamWorks for nearly five years, my goals are more closely aligned with making software that "even a traditional animator could use." In either case, you are looking at a pretty tough road.

In the digital age, the push continues to be for faster and more efficient production pipelines. At DreamWorks, the way we've tried to do this for traditional animation has been through a progression. During the development of ToonShooter, our new Linux-based pencil test system, the goal was to make the current process as quick and painless as possible. We focused a great deal of time on understanding what the traditional animators do and how we could help them do the mundane things faster. This led to a number of new features and enhancements that might not have occurred to us without their involvement. Now that we have gained confidence in providing tools that make their current process as efficient as possible, we are looking at how much faster we could make things if we changed their process. This is where our next stage of development is headed. Can we allow the artists to do what they do best in a way that fits more easily into the digital world? Our development efforts include:

- Digital drawing tools
- CG animation tools geared toward traditional animators
- Remote collaboration
- Integration with other digital departments (editorial and layout)

As we continue to travel down this road of making tools for traditional artists, we're finding it to be an intriguing journey.

Derek Chan has served as a software project manager at DreamWorks on the animated features "The Prince of Egypt" and "The Road to El Dorado." One of the projects Chan helped oversee was setting up the studio's batch queue system, which was used on "The Prince of Egypt" and "The Road to El Dorado," and is currently in use on the forthcoming animated feature "Spirit: Stallion of the Cimarron." Chan has also worked on the studio's new Linux-based pencil test system, ToonShooter, which is now being used for DreamWorks animation projects. In addition, Chan has been involved in pipeline utilities, where he manages and develops software that makes the production pipeline run more efficiently. For Software Operations, he manages a group of six developers who work closely with production to identify and solve development issues.

Prior to joining DreamWorks, he worked at SGI as a member of their SoftWindows development team, where his focus being on multimedia playback. He also worked at IBM on an electronic installation program for Windows and OS/2. He earned a bachelor of science and electrical engineering at the University of California, Los Angeles and studied computer science at Stanford University.

Ivo Horvat
It is no secret that computer graphics technology is becoming more accessible everyday to the less technically minded. This has had the effect of shifting the preferred job requirements away from those who have computer science degrees to those who have more developed artistic training. In the past, simply wading through an interface was sometimes a major accomplishment achieved only by the select few. Those few more technically minded specialists were very highly paid and highly regarded, and they had total creative control over the work, because no one with creative skills had enough technical knowledge to confidently direct the work. The result was that the work had a distinct lack of artistic involvement on both sides of the equation: the work that was delivered, and the tools that were conceived to achieve it. The overwhelming attitude at the time seemed to be fear of approaching technological voodoo.

Today however, leaps and bounds have been made in the areas of technological engineering. Even though nothing is quite as intuitive as an analog device, such as a pencil or a paintbrush, technology is bridging the gap, in both hardware and software. The upshot of all of this is that the technological controls are becoming more transparent, and they reveal the artistic shortcomings of their users more quickly.

Ultimately, it is the brain that steers the hand to utilize either brush or stylus. To say that the art is in the medium would be as silly as to say that one artist is more evocative simply because her brushes were treated with a more technologically advanced process. Thousands of years of art history have taught us why this is not so.

Ivo Horvat began his career in the entertainment industry in 1992. After leaving Art Center College of Design, where he was studying transportation design, he quickly secured an agent and began freelancing as a conceptual artist and illustrator. Over the next two years, he did work for clients such as Ridley Scott and Assoc., and Taco Bell. In 1994, he joined the newly formed visual effects facility Sony Pictures Imageworks. Over the next four years, he contributed paintings for the films "Tall Tale," "Speed," "Judge Dredd," "The Cable Guy," "Virtuosity," "Anaconda," "Phenomenon," "The Ghost and the Darkness," "Contact," "Starship Troopers," "The Postman," and "Snow Falling On Cedars."

Utilizing his background in industrial design and illustration, he contributed to the Imageworks art department, creating conceptual artwork for a number of films, including: "James and the Giant Peach," "Harold and the Purple Crayon," "Anaconda," and the first incarnation of "Godzilla." In 1998, joined the matte painting department at Industrial Light + Magic, where he applied his unique talents to "Star Wars:

Episode One," "The Mummy," "Wild Wild West," "Galaxy Quest," "The Perfect Storm," "Space Cowboys," "Impostor," "E.T." (15-year anniversary re-release), and "The Mummy Returns." Projects for ILM's commercial division included the Star Wars: Episode One Pepsi campaign and the campaign for First Union Bank, which won an Emmy for Best Visual Effects. In 2001, at the request of Ken Ralston, he re-joined Sony Pictures Imageworks to head the matte painting department. He currently oversees matte painting on: "Spiderman," America's Sweethearts," "Stuart Little 2," and "Harry Potter."

Steven Markowski
My attitude when I made the transition from traditional to computer animation was fairly simplistic: "Good animation is good animation. All I need to do is learn the new tool and it's basically the same thing." To a large extent, this is true. The principles of animation remain the same no matter what the medium. But now I think the success of traditional animators attempting to transition to the computer are largely dependent on how they approach their work. Animators who work very intuitively or rely heavily on their strength in drawing can become frustrated by a medium that has only peripheral use for their drawing skills and is too complex to allow excessive intuition. However, those with a more analytical approach to animation, who enjoy honing actions and performances more than drawings, can find it a medium that offers them a greater level of sophistication than they can find in the traditional animation world. There is also a world of creative freedom and exploration that opens up to them when they are given that greatest of gifts that the digital realm has to offer: the "undo" button.

Steven Markowski was born in Brooklyn, New York. Since graduating from the California Institute of the Arts in 1987, he has worked in a variety of traditional animation and story positions for numerous studios, including Disney, Fox, and Turner. By 1996, he had taught himself how to animate on the computer, and he was chosen to supervise the title character for Warner Brothers' "The Iron Giant." He is currently the Animation Director at Cinesite Visual Effects in Los Angeles, where he recently finished supervising the animation for A.M.E.E., the robot star of Warner Brothers' "Red Planet."

Sande Scoredos
In recent years, I have seen a tremendous increase in the number of people who enter the computer graphics field with a strong traditional arts background and a good foundation in digital technology. There is no substitute for a good foundation in both traditional and digital skills. Anyone working in animation today would benefit from learning as much as they can about computer tools and traditional art forms. Artist, technicians, and developers gain a better understanding of how to create and use digital tools by working in both the traditional and digital forum.

Sande Scoredos is executive director of technical training and artist development at Sony Pictures Imageworks. She has a background in production tools and methods used in creating computer graphics imagery in the scientific, engineering, gaming, video, and film effects industries. Her technical knowledge includes work in 3D from computer animation techniques to radiosity and volumetric rendering, and she has an extensive background in art education, computer science, and 2D and 3D computer graphics production. Her background in studio art led her to teach at the professional studio and university level. Adding computer science and engineering to her credentials, she began teaching microwave engineering design on 2D UNIX CAD systems. The emergence of UNIX-based 3D computer graphics in the mid-1980s enabled her to combine art and computer technology. As manager of training at Wavefront Technologies for many years, she designed the worldwide training program and curriculum, instructing professionals in the use of 3D computer graphics and animation for broadcast, engineering, gaming, and scientific visualization. She then moved on to Rhythm & Hues, where she again designed a training facility and curriculum, and focused on teaching proprietary software tools and production methods to novice and experienced digital production artists. In 1997, she joined Sony, where she has once again set up a training facility for a production studio. She educates experienced artists to use the tools they need to produce world-class imagery. This training program is also designed to enrich the aesthetic, as well as the technical skills of the artists, and to provide artistic career development.

She is very committed to education. She works with schools to review reels and portfolios for student projects and participates with Sony recruitment at festivals and job fairs. As a UCLA alumna, she is very active in the UCLA Professional Entertainment Studies program and teaches 3D computer graphics courses in the Digital Creation program. She is also chair of the SIGGRAPH 2001 Computer Animation Festival.

Tom Sito
Hollywood is a place that frequently like to turn itself upside down over new technologies. But the problem in this mania for change is how to exploit the strengths of the new technologies and still preserve the traditional skills of filmmaking, animation, and story telling. For movies, technology is not an end in itself. The ultimate goal is a good story well told. The time is coming when audiences will stop granting CGI animation a curve because it has not yet reached its potential. The audience demands quality as good or better than the traditional paint and pencil could ever achieve.

Tom Sito is a 26-year veteran of animated film production. His screen credits include the Disney classics "The Little Mermaid," "Beauty & the Beast," "Aladdin," "The Lion King," "Who Framed Roger Rabbit?," "Pocahontas," "Fantasia 2000," and "Dinsosaurs." At DreamWorks SKG, his talents contributed to "The Prince of Egypt," "Antz," "Shrek," "Spirit," and "Paulie." He has just co-directed Warner Brothers' "Osmosis Jones."

He teaches at the University of Southern California and has written numerous articles on animation. He has lectured at New York University, SVA, UCLA, AFI, the annual SIGGRAPH conference, Microsoft, Capilano College, Sheridan College, Ecole du Grand Gobelin, Palma Majorca, and the Yomiuri Forum in Tokyo. He is president of the Motion Picture Screen Cartoonist's Union Local #839, were he is an outspoken advocate for the rights of artists.

The CAVE and Beyond: VR Art in Museums and Galleries

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Jeffrey Shaw
Zentrum für Kunst und Medientechnologie

Immersive, interactive VR systems (CAVEs, domes, etc.) deliver unique artistic, entertainment and educational experiences. Worldwide, there are a growing number of such systems open to the public on a daily basis. This panel examines the historical strengths and weaknesses of using VR in public spaces and the challenges of creating VR experiences for different kinds of audiences. We discuss how the use of VR has expanded; whether the "wow" factor continues to play a stronger role in attracting an audience than the work itself; what has really worked; and what the problems are. We contemplate the directions (aesthetics, content, and technical advancements) for VR as a public display medium.

The motivation for convening this panel is threefold: to discuss VR production and VR installation for public display; to examine the cross-over of the latest technical research into art practice; and to create a forum where the panelists and members of the audience can pool information, learn from each other, and delineate controversial areas.

Josephine Anstey
In a typical VR experience, you share the CAVE with a group, flying together across galaxies, watching molecules mate, effecting turbulent gas flows, meeting virtual guides. But what if the guide wants to whisper you a secret? What if you don't want your interactions watched by all the others? I develop virtual fiction experiences. Unlike a novel or film where the audience identifies with the main protagonist, in this fictional form, the user is the main protagonist. For the experience to have the most impact, the user must feel comfortable and confident enough to engage with the piece physically and emotionally. This often means being alone with the piece. The high cost of immersive projection technology (IPT) systems makes them rare in the kind of spaces (museums, galleries, conferences, and festivals) where my VR Fiction shows; their popularity and the economics of throughput make an experience for one user alone unfeasible. Yet I believe that such an intimate setting is crucial for this type of application. The next step is a prototype IPT system that is cheap enough to be widely used for one-on-one experiences in art exhibitions and robust enough for daily wear and tear.

Josephine Anstey is a virtual reality and video artist. Her latest work is an immersive VR fiction, "The Thing Growing." She has collaborated on "Shared Miletus," a networked VR piece, and the "Multi Mega Book in the CAVE," winner of a Multimedia Grand Prix 97 Award from the Multi-Media Content Association of Japan. These VR pieces have shown widely in the US, Europe, and Japan. Since 1983 she has collaborated on a series of videos with video artist Julie Zando, which have shown internationally and won awards including the Best Narrative Video Award (Atlanta Film and Video Festival, 1990) and Best Experimental Video Award (Atlanta Film and Video Festival, 1989). Many of the videos are in the permanent collection of the Museum of Modern Art in New York. She is currently a visiting assistant professor at the University at Buffalo.

Donna Cox
In our work with the American Museum of Natural History Hayden Planetarium, my collaborators and I use CAVE technology not only as a display device, but also as a remote production tool. We regularly do Champaign-New York sessions to develop new exhibits using Virtual Director, a choreography tool developed by three artists: Donna Cox, Robert Patterson, and Marcus Thiebaux. The digital dome at the Hayden is like a seven-wall CAVE with edge blending. Projectors throw 70 feet, creating a hemisphere where 440 museum attendees can go on a tour from earth, to the Milky Way, to the Virgo Cluster, and beyond into the large-scale structure of the universe. Our team contributed over four minutes of visualization to the Passport to the Universe digital dome exhibit, and we are currently working on the Big Bang. The digital tours are created from observational and computational data that is artistically choreographed, colored, and rendered. Artists, technologists, and scientists work together to develop content for these large displays. Over two million people have seen Passport to the Universe. The new Big Bang exhibit is scheduled to open 4 July 2001.

Donna Cox is professor in the College of Fine and Applied Arts, University of Illinois, and a research artist/scientist at the National Center for Supercomputing Applications. She is a recognized pioneer in scientific visualization. She was appointed to the editorial board for Leonardo Journal and elected as a voting council member of the Internet2 Strategic Applications Council. She was associate producer for scientific visualization and art director for the Pixar/NCSA segment of "Cosmic Voyage" the IMAX film nominated for an Academy Award in 1997.

Horst Hörtner
The City of Linz opened the Ars Electronica Center (AEC) in September 1996 as a Museum of the Future. The museum includes the first CAVE that was open to the public in an institution that is equally dedicated to art and technology. The CAVE environment was specifically designed with the knowledge that it would be heavily used on a daily basis for presentations of all kinds (art, research, industry, architecture, medicine, etc.). To support a CAVE and many changing applications, it is not enough to have specially trained technicians. To create new applications for the Ars Electronica Center's CAVE, the center's development laboratory, Futurelab, is crucial. Its main goals are: to give the computer art community a place to exhibit and work on production (art research); to increase the possibilities for local industry to work with high-end VR equipment on application-based research in VR without incurring immense investments.

Horst Hörtner is technical director at Ars Electronica Center, where he is responsible for designing and setting up installations, including the CAVE. In 1997, he became director of Ars Electronica FutureLab, where he directs design of virtual environments, concepts for interactive installations, and systems design for Web-based applications. In 1997, he also became a Member of Christian Doppler Laboratorium for software engineering at Johannes Kepler Universität, Linz and associate professor at the Universität, für künstlerische und industrielle Gestaltung, Linz. In 1998, he became a Member of the Multimedia Content And Broadband Expert Group (5th Framework Program, European Commission, DGXIII/E-4).

Daniel J. Sandin
A common comment when people first experience the CAVE or even the ImmersaDesk is to say that these devices would have tremendous application in entertainment and museum settings. The chief success of projection-based VR has, however, been in the research community. Deploying CAVEs or CAVE-like systems and even single screen projection-based VR in museum settings has been much less frequent than expected. I think the problem with placing these devices in museums and galleries can be summarized as: they cost too much money, they take up too much space, they have too little throughput, and they have expensive glasses and tethered tracking systems. There are developing technologies that can change this situation. The falling cost of computation, revolutions in projection technology, and the emergence of flat-panel displays provide opportunities to address these issues. I discuss how to apply these technological changes to the design of projection VR installations in a museum context: In particular, two new designs utilizing polarization-based LCD projectors, the Front Projected ElsieDesk and a tripod arrangement of three rear-projected screens.

Daniel J. Sandin is director of the Electronic Visualization Laboratory and professor in the School of Art and Design at the University of Illinois at Chicago. His early interest in real-time computer graphics/video image processing and interactive computing environments motivated his pioneering work in video synthesizers and continues to influence his research interests. He is recognized, along with EVL co-director Tom DeFanti, for conceiving the CAVE virtual reality theater in 1991. Sandin's computer/video art has been exhibited at conferences and museums worldwide. His work is included in the inaugural collection of video art at the Museum of Modern Art in New York. He has received many grants and fellowships from such distinguished organizations as the Rockefeller Foundation, the Guggenheim Foundation, and the National Endowment for the Arts.

Paul Sermon
My current research involves the combination of live-action telepresent videoconferencing composited into immersive virtual environments utilising CAVE-based augmented spaces for public exhibitions. The reduction of CAVE-based systems to consumer PC accessibility is making it possible to customize the conventional four-wall CAVE into new interactive museum/gallery exhibits; integrate CAVE-based environments within telepresent installations that necessitate new projection methods for thematic experiences; and explore new architectured projection forms including corridors, alcoves, and staircases. This current research is developing a telepresent CAVE installation of connected rooms that will interface seamlessly with its physical surrounding – an interactive narrative and virtual environment that incorporates the physical installation space directly.

Paul Sermon is guest professor at the Academy of Art and Design in Linz, Austria. He is also reader in creative technology at The University of Salford, Research Centre for Art & Design, Manchester, England. He was awarded the Prix Ars Electronica Golden Nica in the category of interactive art, for the hypermedia installation Think about the People Now, in Linz, Austria, September 1991. He worked as an artist in residence and produced the ISDN video conference installation Telematic Vision at the Zentrums für Kunst und Medientechnologie in Karlsruhe, Germany, from February to November 1993. He received the Sparkey Award from the Interactive Media Festival in Los Angeles for the telepresent video installation Telematic Dreaming in June 1994.

Jeffrey Shaw
Many artists are deeply attracted to the unique expressive and experiential possibilities of immersive CG environments such as the CAVE. At the same time, we have to grapple with the related problems of locating and using technologies of this kind for a mass public. I describe four installations that demonstrate innovative technical and artistic solutions enabling public experience and interactivity with such technologies. PLACE is a 360-degree projection environment in which the viewer controls rotation of a large projected image from a motorized platform in the center of a large cylindrical screen. EVE (Extended Virtual Environment) is similar to PLACE in its functionality but uses an inflatable dome and a spherical projection surface so that the projected image can be interactively moved in two axes to create an immersive visualization environment. Room with a View is also a full-dome projection environment, but it uses multiple projectors to completely saturate the dome surface and constitute a fully immersive scene. conFIGURING the CAVE is an application that uses the proprietary CAVE technology but with completely custom software. Attaching cabled interfaces to the viewer was felt to be inappropriate in a museum context, so we developed a unique interface concept: a life-size wooden puppet.

Since the late 1960s, Jeffrey Shaw has pioneered the use of interactivity and virtuality in his many art installations. His works have been exhibited worldwide at major museums and festivals. For many years, he lived in Amsterdam, where he co-founded the Evenstructure Research Group (1969-80). Currently, he is director of the Institute for Visual Media at the Zentrums für Kunst und Medientechnologie in Karlsruhe, Germany. He leads a unique research and production facility where artists and scientists are working together and developing profound artistic applications of the new media technologies. His artworks include: The Legible City, Alice's City, Alice's Rooms, Revolution, the Virtual Museum, Disappearances, EVE, the Golden Calf, PLACE – A User's Manual, conFIGURING the CAVE, The Distributed Legible City, and PLACE – Ruhr.

Designing, Understanding, and Operating Complex Human-Machine Systems

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Robert J. Molloy
National Transportation Safety Board

Many computer-based systems are orders of magnitude more complex than the wireless information appliances that are the current focus of much of the attention of the computer science community. They are often safety-critical systems that have become an important part of the global economy and our daily lives, such as air traffic control, commercial and military aircraft, commercial shipping, municipal rapid transit networks, regional power plants, and oil and natural gas pipelines. This panel calls attention to the problems of interacting with complex, automated systems, describes applications in which appropriate technologies have been successfully applied in the human/machine interface, and points to challenging research issues.

David Zeltzer
David Zeltzer is vice president and chief technical officer at the Fraunhofer Center for Research in Computer Graphics (CRCG) in Providence, Rhode Island. He is also adjunct associate professor of computer science at Brown University. In addition to work in virtual environment technology, his research interests include human-machine interface design and knowlege-based visualization systems. He is a senior editor of the MIT Press journal Presence: Teleoperators and Virtual Environments and he is the author or co-author of more than 30 technical publications on virtual environments and human-machine interfaces.

Bill Buxton
The three basic rules of real estate (Location! Location! Location!) apply just as well to human-machine interface design. Tell me where a system or device will be used, and I will know an awful lot about its interaction and usability requirements. We can learn a lot from technologies developed by native peoples that allow them to negotiate hostile environments, which would render useless many of our much-touted wireless, GPS-equipped devices. The lesson is that less is more. Throwing technologies at a problem is far less important than understanding well the needs and capabilities of the human users. This applies across a wide range of computer-based systems being deployed today.

Bill Buxton is chief scientist at Alias|Wavefront and its parent company SGI, as well as an associate professor in the Department of Computer Science at the University of Toronto. He is a designer and researcher concerned with human aspects of technology, and his work reflects a particular interest in the use of technology to support creative activities such as design, filmmaking, and music. His research specialties include technologies, techniques and theories of input to computers, technology-mediated human-human collaboration, and ubiquitous computing.

Christopher A. Miller
Applying sophisticated, adaptive, and intelligent "information presentation automation" to manage information flow to human consumers in complex systems and domains is not a panacea. At SMArt Information Flow Technologies, our experience includes design of adaptive automation and information systems for multiple "high-end" domains including fighter piloting, attack/scout helicopter piloting, petrochemical refining, and communications resource management for military command and control. Users in such domains are very demanding and critical of automation that does not behave according to their standards and expectations, and it has proven difficult to create systems that are correct enough to achieve user acceptance. Yet we have found that intelligent interfaces and behaviors can be designed so that perfection is not required, but that value is still provided. Such interfaces require detailed consideration and design of the human-automation relationship. A critical mistake is attempting to make the system too autonomous in its behaviors. Instead, the opportunity for explicit and dynamic collaboration about how the system may best serve the human is critical.

The rotorcraft pilot's associate cockpit information manager (RPA) adaptive information management system provides an example. RPA achieved acceptable levels of usability and statistically significant workload reduction compared to an unaided condition in a series of complex and realistic human-in-the-loop mission simulations. It is important to note that these results were obtained in spite of less-than-perfect tracking of the pilot's intent and pilots' reports of having to "now and then" override or correct RPA's behaviors.

One innovation we employed in the RPA cockpit may have influenced these results: a "Crew Coordination and Task Awareness" display that, unlike some previous systems, gave the two human crew members direct insight into, and some control over, RPA's notion of the mission context and main tasks of each crew member. Pilots' acceptance of this display was very high, averaging 4.25 on a scale of 1-5 where 4 corresponded to "Of Considerable Use" and 5 to "Extremely Useful."

The success of this interface innovation has led us to think more seriously about the implications of the associate metaphor for adaptive automation in many domains. Given our experience in working on intelligent information systems, and our familiarity with others in the literature, we have recently drafted a set of "etiquette rules" for adaptive-system behavior. The notion of etiquette rules seems to have an appropriate focusing effect, both placing an emphasis on behavior acceptable to a human supervisor and requiring a degree of anthropomorphic thinking about the system, which seems to be productive. In this panel, these rules are presented, and the general notion of human-machine etiquette is discussed, along with additional examples from RPA concerning the quantification and tradeoff among rules implemented in that program.

Christopher A. Miller is chief scientist of SMArt Information Flow Technologies (SIFTech). He has over 11 years' experience in creating knowledge representations and computational approaches to adaptive user interfaces, automation, and decision aids. Until recently a research fellow at Honeywell Laboratories, he has led intelligent, adaptive information-system design efforts for domains including management of military communication resources, fighter piloting, attack/scout helicopter piloting, oil refinery operations, commercial aviation operations, and ground-based dispatch operations.

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Robert J. Molloy
The "pitfalls" of automation in the modern glass cockpit have been a topic of discussion for over 20 years. Concurrent with increased automation in the cockpit, however, has been the increased deployment of automation in surface modes of transportation: transit trains are being operated in fully automated environments, pipeline operations are becoming more centralized and computerized, and maritime operations have seen increases in automation on both the bridge and engine rooms with subsequent reductions in manpower. Visions of the future include single-manned ships operating across the oceans. Even highway transportation is moving to highly automated systems with the development of the intelligent transportation system.

Unfortunately, surface modes seem to be experiencing the same difficulties in the growth of automation that faced the aviation industry in the past. The National Transportation Safety Board's investigation of the grounding of the cruise ship Royal Majesty off the shores of Nantucket came across several deficiencies in automated systems on the bridge. Systems that could have prevented the grounding were turned off due to high false-alarm rates. Systems that controlled the movement of the ship were able to fail in ways unanticipated by the crew. Finally, crew complacency and trust in the system prevented adequate monitoring of the systems. The board's investigation of a pipeline rupture in 1996 near Gramercy indicated that the maritime industry was not alone in its discovery of the "pitfalls" of automated systems. The pipeline controller failed to recognize the significance of an alarm due to the high frequency of alarms in the system. Further, the alarm that signaled a leak was given no higher priority than any other alarm.

Central to these discussions is the danger of moving the operator from direct control to passive monitoring. As the operator becomes less involved in direct control, there is the possibility of losing awareness of the system's state or position in the environment. The National Transportation Safety Board investigated one such occurrence in Cali, Columbia with the crash of American Airlines flight 965.

Accidents such as the Royal Majesty grounding and the Gramercy spill indicate that the problem of poor automation implementation continues to occur in surface modes. As such, more must be done to ensure that we do not revisit each of the "pitfalls" of automation previously discovered in the aviation field.

Rob Molloy joined the National Transportation Safety Board in May 1996 as a transportation research analyst. While at the board, he completed a study of aircraft evacuations and statistical reports on occupant survivability in aircraft accidents, and the relationship between accidents and aircraft age. He is currently co-managing a safety study on supervisory control and data acquisition systems in the pipeline industry. He has also been involved in accident investigations involving automation issues in multiple modes of transportation.

Steve Chien
Traditionally, NASA has used robotic spacecraft to explore the far reaches of the solar system by carefully designing spacecraft for the expected environment and controlling the spacecraft using a highly skilled operations team. Next-generation missions involve exploration of rapidly changing environments in situ, such as a lander on the surface of a comet, a submersible in oceans below the ice caps of Europa, and an aerial explorer in the fluctuating atmosphere of Titan. These explorers will need an unprecedented level of autonomy and adaptability to survive, in order to achieve their science goals. Yet other missions propose large numbers of cooperating explorers, such as swarms of rovers, penetrators, and airplanes, to study the climate of Mars.

These semi-autonomous systems present unique interface and interaction issues for their designers and operators. Designers must be able to determine and envision system performance in a wide range of operating scenarios. Operators must be able to understand the effects of high-level goals now used to command the autonomous explorers. The interaction between humans and space systems becomes a peer-to-peer negotiation, and succinctly summarizing group behavior is critical when tracking large numbers of autonomous entities.

In my presentation, I describe some of the challenges of this mixed-initiative, peer-to-peer model, as well as preliminary work at JPL to address these problems.

Steve Chien is technical group supervisor of the Artificial Intelligence Group and principal computer scientist in the Exploration Systems Autonomy Section at the Jet Propulsion Laboratory, California Institute of Technology. At JPL, he leads efforts in automated planning and scheduling for space exploration. He is the technology community lead for autonomy for JPL. He is also an adjunct associate professor with the Department of Computer Science, University of Southern California.

A collection of autonomous rovers and space vehicles that may be part of the scientific exploration of Mars. Jet Propulsion Laboratory, California Institute of Technology

Non-Linear Animation for Production

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Seth Rosenthal
Industrial Light + Magic

"Production studios, 3D animators, and vendors of many popular computer graphics packages are increasingly using the term "non-linear animation," which usually describes a way of working with various types of motion data at a higher level where animation sources are abstracted to transportable snippets. Nonlinear tools can be useful in many areas of production, such as previsualization, animation creation, motion editing, retargeting and reuse, choreography, and actor direction. This panel discusses practical and speculative uses of non-linear animation techniques in a production environment."

Raf Anzovin
Non-linear animation systems (NLAs) represent the first real improvements on the traditional keyframe animation system. A well-implemented NLA is both an animation editing system, with features analogous to those of nonlinear video editing systems, and an animation-compositing tool that enables the animator to create layers of movement and specify Boolean and other interaction modes among them. These extensions of traditional capabilities are, in my experience, quietly revolutionizing animation practice, and they will have greater impact as NLA tools become more familiar to working animators.

At our production studio, NLA software has become an essential part of the animation process. In fact, it is the indispensable facilitator of everything we produce. NLA tools enable our animators to manipulate their work as a composite of separable but interdependent "actions." Actions can be quickly repurposed for different projects, which is crucial for that segment of our business in which we produce sets of training animations that work variations on a single theme. Moreover, actions are easily shared among animators, which enables those with less experience to quickly build on the work of more experienced artists. The result is a more flexible workflow that is fast, efficient, cost-effective, and well-suited to mass production of commercial and industrial animation, and to hand-crafted works of animation art.

Award-winning filmmaker Raf Anzovin is the co-founder and creative director of Anzovin Studio, a rapidly growing animation company that provides character design and animation for film, video, and interactive media. He is the founding instructor of the advanced character animation courses at the Computer Science Department, University of Massachusetts, Amherst, and runs a yearly animation internship program for five college-area students. From 1999 to 2000, he wrote the monthly animation column for 3D Magazine, and since 1996, he has served as contributing editor for MacAddict magazine.

Michael Isner
The main benefits of NLA are:

1. A framework for reducing the complexity of multi-channel animation tasks. This includes blending, layout, cleanup, mirroring, breaking into parts, and assembling. Compounds also speed up manipulation of interdependent channels.

2. Mixing keys, expressions, and constraints open up the opportunity for blends of keys and relations. For example, "canned animation" and live goal blends are useful for a character that is grabbing onto something (where the something may change position).

3. It brings SRT (scale, rotation, translation) animation into a container that can be used in character setup. Because this container can be weighted and driven in a manner similar to shape animation, many of the character-setup techniques that have evolved from facial animation can be implemented on SRTs. Useful applications range from hand setups to universal facial rigs that are independent from form and features.

4. It's a compositing tool for hybrid motion capture and keyed animation workflows. Moving from pre-viz to a finished shot is generally a transition from raw motion capture to refined animation. This refinement can happen in many different ways, ranging from substitution, extraction (a pipeline to convert mocap into keys), and blending.

Michael Isner works through Softimage Special Projects as a consultant for film and game projects. His experience ranges across modeling, rendering, animation, and character setup and he has written copious custom tools for XSI, ranging from mirroring tools to bone matching heuristics and dynamics. Previously, he was the demo lead in the Softimage Content Group, which put NLA through its first production scenarios. Some of his recent character work can be found at: www.isner.com/new.htm

Laurent Lavigne
NLA is an entirely new way to think and deal with motion as an abstraction. The editing paradigm inherent with this abstraction allows the user to focus on events and timing, so it becomes an ideal tool for communication with a director or an editor. Pixel Liberation Front is a company that specializes in pre-visualization for movies and commercials. This is an area where communication with non-technicians is of paramount importance, and one cannot get stuck in the details of animation. NLA was a natural extension of our tool set. It enables pre-viz artists to separate the details of action from the elements of a shot's composition. It eases creation of shots and their deconstruction. It allows, through swapping of motion clips, scaling of the quality of a shot from rough "sliding people" to a fully moving mocaped pre-movie.

Laurent Lavigne is currently working on the pre-visualization of the second "Matrix" movie. In this process he is animating and deconstructing complex stunts and fight sequences. He became part of the pre-viz team at PLF on David Fincher's last

production, "Panic Room," which (unusually) required pre-viz of the entire movie. Prior to that, he worked for four years in post production, supervising character animation special effects for movies and commercials ("Mortal Kombat," "DnD," Radioshack, Snickers, and others). He started his career in the US working in the gaming industry as a designer and supervisor of animatics. He moved to the US to attend film school at the University of Southern California, where he received an MFA. He also has a master of computer science from Jussieu in Paris, with an emphasis on user interface and L-system fractals.

Greg Punchatz
My first reaction to the concept of NLA was the same as the reaction of many other animators. I thought it was a cute software demo, but I probably would never really use it very much. I was wrong. Now I use NLA every day, in ways I never imagined. One of the more interesting things we have done with it was editing a three-minute short film in XSI, where we switched among 35 different cameras using the Animation Mixer. This led me into the whole concept of non-linear film making, in which you could have animators, compositors, and editors on set with the rest of the crew for roughing out effects and edits while scenes are being shot. I really believe this is the future of filmmaking.

Greg Punchatz is director of animation at Janimation. He comes from a background of special makeup effects and animatronics, and he has an artistic family (his father is a well-known illustrator, Don Ivan Punchatz). He attributes his attention to artistic detail to the long hours spent watching his father create his magic through painting. He had an early fascination for fantastic characters, which led to his first career as a special-effects makeup artist. Some of his credits include: the "Robocop" trilogy, "Coming to America," and "Nightmare on Elm Street 2." He has also created stop-motion models for various video games, including the mega-hit Doom.

After seeing Jurassic Park for the first time, he knew that he would have to change his "set of tools" if he wanted to continue creating cutting-edge characters. In 1995, he joined Janimation and traded in his sculpting tools for a mouse. One of Greg's favorite projects to date is a CG turtle for Harrah's Casino, which won the "Big Kahuna" award for commercial animation last year.

Seth Rosenthal
Motion-captured animation is a lot like keyframe animation, but it has important characteristics that motivate an emphasis on different editing techniques. In particular, the data are dense and difficult to edit directly. Higher-level editing techniques such as NLA and layer-based editing allow animators to easily manipulate important aspects of motion-capture animation without having to directly edit the original dense data. In addition, the ability of motion capture to generate a large volume of realistic human animation encourages development and use of techniques that can manipulate a library of existing animation as raw material to be formed into new and different performances. NLA and related techniques not only provide artists with better tools for manipulating animations, but they also increase the value of existing collections of animation data.

ILM has used motion capture in shots ranging from dramatic hero performances of the title character in "The Mummy" and "The Mummy Returns" to large crowds in the battle sequence of Star Wars: Episode One "The Phantom Menace" and the intricate three-person dance routine in the Rhythms, Data Dancers commercial. These shots involved complex multi-character performances, elaborate interaction with elements in the live-action plate, and choreography of entire armies. In order to complete this work, we relied on a wide range of animation editing techniques including manual adjustments, animation layering, blending, re-timing, and procedural crowd simulation. In addition, many of our shots made use of secondary simulations of cloth, armor, or flesh, which imposed limits on the physical plausibility of the underlying animation by magnifying editing artifacts such as excessive accelerations. We are working to extend the usefulness of motion capture as a tool for feature film production by exploiting a range of editing techniques that allow us to provide directors with more flexibility in experimenting with and modifying animation and choreography.

Seth Rosenthal joined ILM in 1998 as motion capture supervisor, where he oversees recording and processing of motion-capture data for feature film and commercial productions, and works with the research and development department to develop new technology for integrating motion-capture techniques with ILM's visual effects production pipeline. At ILM, he has supervised motion-capture production for Star Wars: Episode I "The Phantom Menace," "The Mummy," and the Rhythms, Data Dancers commercial. He is currently working on "The Mummy Returns," "Pearl Harbor," and "A.I."

Before joining ILM, he managed production of 3D content for Microsoft's Digital Media Center, where he collaborated with the Human Figure Animation Project at Microsoft Research to adapt their motion-capture processing and animation system for use in production. He earned a bachelor of arts in history from Oberlin College in 1988.

Gordon Cameron
Gordon Cameron is development manager for Softimage|XSI. He previously served as project leader for animation and a lead developer on the animation mixer NLA and has worked over the years in other areas such as motion capture, real-time viewing, performance animation, etc. He organized a SIGGRAPH 97 panel on motion capture and character animation and was editor of SIGGRAPH's Computer magazine from 1996 until 2001. He previously worked in the fields of parallel computing, robot vision, and scientific visualization.

Immersed in Anxiety or a Process to Healing? VR meets Mental Health

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Guest "Challenging" Panelist
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Behavior Journal

Virtual Reality (VR) technology has undergone a transition in the past few years that has taken it out of the realm of "expensive toy" and into that of functional technology. Although media hype may have oversold VR's potential during the early 1990s, computer-based simulation technology is now beginning to emerge as a viable tool for cognitive and behavioral mental health applications.

Virtual reality integrates real-time computer graphics, body tracking devices, visual displays, and other sensory-input devices to immerse a participant in a computer-generated virtual environment (VE) that changes in a natural way with head and body motion. Much like an aircraft simulator serves to test and train piloting ability under a variety of controlled conditions, VEs can be developed to present simulations that can be used to target human behavioral and cognitive processes that are useful for mental health applications. The capacity of VR to create dynamic three-dimensional stimulus environments, within which all behavioral responses can be recorded, offers assessment and intervention options that are not available using traditional methods. In this regard, a growing number of laboratories are developing research programs on the use of VEs for these purposes. As a result, controlled studies reporting encouraging results are now beginning to emerge.

VR applications have shown promise for addressing: fear reduction with phobic clients; pain reduction for burn victims; stress/pain reduction in cancer patients; eating disorders/body image disturbances; spatial navigation training in children with motor impairments; functional skills in persons with developmental disabilities and autism; and assessment and rehabilitation of memory, attention, visuospatial processing, motor skills, and executive cognitive functions in persons with central nervous system dysfunction and the elderly. These therapeutic targets reflect an informed appreciation for the unique assets that are available using virtual technology and provide a foundation of work that is supportive of the further development of VR cognitive behavioral applications. If the associated technology continues to advance in the areas of visual displays, graphics, computing speed/memory storage, 3D audio, wireless tracking, voice recognition, intelligent agents, and VR authoring software, then more powerful and naturalistic VR scenarios will be possible. These advances could result in more readily available desktop-powered VR systems with greater sophistication and responsiveness. This inevitable increase in access will allow for more widespread application of VR technology for clinical assessment and intervention purposes. However, many unanswered questions and issues must be addressed before these types of VR applications can usefully move into mainstream practice.

The panelists have designed and developed VR applications that target a wide spectrum of mental health areas. This group consists of some of the top VR/mental health scientists, who discuss their work using VR to assess and treat persons with phobias, post-traumatic stress disorder, burn and cancer related pain, traumatic brain injury, attention deficit/hyperactivity disorder and learning disabilities, and for specific age-related assessment. The panelists informally present their work in four unified-by-topic groups, less as a "lecture" and more as a discussion among colleagues on a particular topic. Following these presentations, the guest panelist, Mark Wiederhold, assumes a "devils advocate" role and "challenges" the panelists on topics of concern (ethical/legal, accessibility, digital divide, certification for use, side effects, long-term usage, limitations for use, social ramifications) and on what is needed to advance this technology into the 21st century in a rational manner. The remaining time is devoted to lively panel and audience discussion of the key issues involved in development and implementation of VR applications and where we are heading in the future.

Skip Rizzo
Albert "Skip" Rizzo received his PhD in clinical psychology from the State University of New York at Binghamton. He has joint faculty appointments with the University of Southern California Integrated Media Systems Center (IMSC) and the USC School of Gerontology. He is also the director of the IMSC Virtual Environments Lab, which designs, develops, and evaluates the usefulness, feasibility, and efficacy of virtual reality systems targeting assessment and rehabilitation of spatial abilities, attention, and other cognitive functions. Additionally, he is conducting research on 360-degree panoramic video HMD applications for exposure therapy (currently social phobia), computerized facial recognition, and facial avatar animation. He is also designing better human-computer interaction systems for the elderly and persons with disabilities. His other IMSC activities involve provision of human-factors input on IMSC projects in teleimmersion as well as research on integration of immersive audio in virtual environments.

He is the associate editor of the journal CyberPsychology and Behavior and is on the editorial boards of The International Journal of Virtual Reality, Cognitive Technology, and Presence: Teleoperators and Virtual Environments. He is the creator and manager of the Virtual Reality Mental Health Email List server (VRPSYCH). He also chaired the SIGGRAPH 2000 panel on this topic and is an internationally known speaker in this area, presenting at numerous professional events and conferences. Prior to his USC affiliation, he was a cognitive rehabilitation specialist for eight years, developing and implementing cognitive rehabilitation programs for clients with traumatic brain injuries.

Larry F. Hodges
Larry F. Hodges is associate professor in the College of Computing and head of the Virtual Environments Group at Georgia Institute of Technology. He is also co-founder of Virtually Better, Inc., a company that specializes in virtual reality exposure therapy of anxiety disorders in Atlanta. He received his PhD from North Carolina State University in computer engineering (1988), a MS in computer science from NCSU (1984), a MA in religion from Lancaster Theological Seminary (1978), and a BA with a double major in mathematics and physics from Elon College (1974). His research interests are in software and algorithm development, experimental quantification, and application development for virtual reality systems. He is on the editorial boards of the journals Presence: Teleoperators and Virtual Environments and CyberPsychology and Behavior, and is a member of the Steering Committee for the annual IEEE Virtual Reality Conference.

Hunter Hoffman
Hunter Hoffman studied memory at Princeton University and investigated human memory and attention with eyewitness/false-memory expert Elizabeth Loftus. He is a project manager at the University of Washington Human Interface Technology Laboratory and an affiliate faculty of psychology. He studies the use of immersive VR to help reduce pain during wound care in burn patients at Harborview Burn Center. He also conducts controlled laboratory experiments exploring the relationship between the illusion of "presence" in virtual reality and analgesic effectiveness (attempting to maximize analgesic effectiveness). In other projects, he is exploring the use of VR exposure therapy for treating spider phobia, the value of adding tactile cues (position-tracked toy spiders) to increase treatment effectiveness, and using real (mixed reality) chocolate bars to add taste to virtual objects. He has published over 20 peer-reviewed manuscripts, including six in the Journal of Experimental Psychology. He presented at panels on virtual healing at SIGGRAPH 98 and SIGGRAPH 2000, and at the SGI booth at SIGGRAPH 98. He will be giving immersive demos at the MultGen-Paradigm booth at SIGGRAPH 2001.

His research has been covered by CNN, Scientific American Frontiers, the BBC, and the Discovery Channel. He has served as an ad hoc reviewer for JEP:LMC, Psychological Sciences, Presence: Tele-operators and Virtual Environments, SIGGRAPH 99, the Journal of Applied Psychology, and ACM Transactions on Human Computer Interaction. He is also a scientific advisor to VR researchers in Spain and Japan.

Dorothy Strickland
Dorothy Strickland is president of Do2Learn, a computer software company developing virtual reality games for children with autism and related learning disabilities. Her present project, funded by the National Institutes of Health, has designed Web-playable virtual reality games that help children with special needs learn safety and social skills. She is also an adjunct faculty member at North Carolina State University and has presented her research at various conferences including SIGGRAPH 96, SIGGRAPH 98, and SIGGRAPH 2000; the new 2001 game conference Entertainment in the Interactive Age sponsored by the Annenberg Center; and VRAIS, the largest international VR conference, where she has been the keynote speaker. She has published her work in numerous journals, including serving as guest editor for the Communications of the ACM special SIGGRAPH 97 edition on "Virtual Reality and Mental Health." Her research has been reported in several news sources worldwide, including an Associated Press feature and a more recent Discovery Channel special aired in 2001.

Benjamin Watson
Benjamin Watson is assistant professor in computer science at Northwestern University. He earned his doctoral and masters degrees at Georgia Tech's Graphics, Visualization and Usability Center, and his bachelors degree at the University of California, Irvine. His dissertation focused on user-performance effects of dynamic-level-of-detail management. His other research interests include model simplification, visual fidelity, tangible interfaces, information visualization, computer games, and spatial applications of computer graphics. He is on the conference committee for the IEEE VR 2001 conference, and is program co-chair for the Graphics Interface 2001 conference.

Maria Schultheis
My Maria T. Schultheis is a clinical research scientist in the Neuropsychology & Neuroscience Laboratory and an instructor in the Department of Physical Medicine and Rehabilitation at the University of Medicine and Dentistry of New Jersey-New Jersey Medical School. Her clinical and research experience have focused on rehabilitation of cognitively impaired populations, including patients with traumatic brain injury, multiple sclerosis, and stroke. Her expertise is in the area of driving capacity following neurological involvement, focusing on the cognitive demands of driving and the development of new driving assessment protocols. This includes research focusing on application of new technologies such as virtual reality for neuropsychological assessment and treatment. Her research has received funding by such organizations as the National Institutes of Health, the National Multiple Sclerosis Society, and the National Institute for Disability and Rehabilitation Research. She is active in several professional organizations related to neuropsychology and rehabilitation, and currently serves as an editorial consultant to the Journal of Head Trauma Rehabilitation, Rehabilitation Psychology, and the Archives of Physical Medicine & Rehabilitation. She also serves on the Transportation Research Board of the National Research Council.

Brenda K. Wiederhold

Brenda K. Wiederhold serves as director of the Center for Advanced Multimedia Psychotherapy and the Center for Applied Behavioral Services at the California School of Professional Psychology Research and Service Foundation in San Diego. She is a licensed clinical psychologist and has a doctorate in clinical health psychology. She is nationally certified in both biofeedback and neurofeedback by the Biofeedback Certification Institute of America. She serves on the editorial board of CyberPsychology & Behavior and is recognized as a national and international leader in the treatment of anxiety and phobias with virtual reality exposure therapy, having completed over 1,000 VR therapy sessions. CAMP maintains comprehensive programs to treat fear of flying, fear of driving, claustrophobia, panic disorder and agoraphobia, social phobia, fear of heights, fear of public speaking and eating disorders using a combination of cognitive-behavioral techniques, virtual reality exposure therapy, and physiological monitoring. She completed a masters in business administration, has 19 years experience as chief financial officer of an investment firm, and was a former government auditor. She currently is completing her third book and has over 50 publications. She serves as chief executive officer of VRHealth.com, a company that develops virtual environments and conducts clinical research studies using virtual environments and Internet-based worlds.

Mark Wiederhold

My interest in virtual Mark D. Wiederhold is a physician executive with a diverse background in academic health, clinical research, and product development. At Science Applications International Corporation, he invented and patented a non-invasive method for cancer diagnosis that is currently in phase II testing at Tripler Army Medical Center, Honolulu. He also developed a PC-based rugged portable diagnostic medical device for the US Navy and Marine Corps that is currently deployed to the Pacific Fleet. This device was approved by the FDA in four months, and was funded by Congress for two years. He has eight years' experience developing telemedicine systems, including wireless data transmission protocols. He was formerly director of clinical research at the Scripps Clinic in La Jolla, California where he has been a staff physician for the past 15 years. He completed an internship and residency in internal medicine and critical care medicine at the Scripps Clinic. He is on the faculty of the University of California, San Diego Medical School and professor of health psychology at the California School of Professional Psychology in San Diego. He is the editor-in-chief of CyberPsychology & Behavior and editor-in-chief of IEEE Transactions in Experimental Biology and Medicine. He serves on several advisory, editorial, and technical boards. He completed an executive MBA program at the University of California, San Diego, and he is a Certified Physician Executive, a Diplomate of the American College of Physician Executives, and a Fellow of the American College of Physicians. He has over 150 scientific publications.

Internet Appliances: New Horizons for the Web

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Panelists
Seamus Blackley
Microsoft Corporation

Kent Libbey
Excite@Home

Andrew Luan
Metricom, Inc.

Gregory D. Abowd
Georgia Institute of Technology

This panel provides an overview of emerging Web technologies that are fueling the broad range of internet appliances that are starting to appear. While some of these devices are capable of presenting rich media technologies, many are not even capable of presenting full HTML. Enhanced graphics, sound, and animation may not be feasible on many of these devices. Yet many have much more capabilities than even today's personal computers. Will this drive a "lowest common denominator" approach to these devices, or will other factors influence their capabilities? Will Web-based advertising continue to wane? Will other financial models be needed to fuel content for these devices? Will bandwidth be the driving technology?

Mickey W. Mantle
A member of the University of Utah gang, Mickey W. Mantle was a contributor to many early computer graphics products from Evans & Sutherland and Pixar, including Pixar's RenderMan software. He has a degree in computer science from the University of Utah and has been attending SIGGRAPH conferences regularly since 1978. He last chaired a SIGGRAPH Panel in 2000.

After joining Broderbund Software in 1991 as vice president of engineering/chief technical officer, he managed technology initiatives and contributed to development of many successful and award-winning products including Living Books, Myst, Riven, and many more. In 1999, he joined Gracenote (formerly CDDB, Inc.) as vice president of development, where he oversees all development of Gracenote Internet services. This includes software for enabling CD audio player applications such as MusicMatch Jukebox, RealJukeBox, WinAmp, Apple's iTunes, and many others.

Seamus Blackley
Connected Internet appliances will make their way into the living room in a big way with the next generation of video game machines. These appliances are multi-purpose devices that play CDs, DVDs, and, of course, video games. Plus they are inherently connected to the Internet, because they are designed for broadband connectivity from the outset. These devices will spawn a new generation of applications for the living room that utilize extremely rich media and expect connectivity and high-bandwidth capabilities. They will also be fun to interact with!

Seamus Blackley oversees advanced technology development for Microsoft's Xbox, a consumer-oriented video game machine capable of advanced 3D graphics, CD and DVD playback, and Internet connectivity. The Xbox is scheduled for launch in the United States in September 2001. Prior to Microsoft, he was the project lead on a major game title at DreamWorks SKG, and before that he applied his PhD in physics at Looking Glass Software, where he developed the highly lauded flight physics for its Flight Unlimited game.

Kent Libbey
Among these new devices will be "broadband TV" systems that display directly to television (as the only monitor in most living rooms and other communal spaces in the home – kitchens, bedrooms, etc.) and are connected to broadband networks, either directly or indirectly (for example, through a home area network). User interface design and development for such devices involves a different set of constraints and opportunities than designing content and applications for a PC. Lower resolution, navigation with a remote control (rather and a mouse and keyboard), group viewing, and several other factors need to be considered in this design.

Kent Libbey is responsible for development of advanced TV products for Excite@Home, extending the company's broadband content, applications, services, infrastructure, and operations to the TV and other home entertainment outlets. He oversees a staff of 50 people, including product managers, engineers, and user-interface developers. His work in interactive television began in 1993 as director of product management for Bell Atlantic Video Services, where he established and led a staff of marketing and operations professionals, building and running the world's first all-digital video-on-demand television service trial delivered over DSL. Later, as vice president of operations at Tele-TV, a joint venture of Bell Atlantic, Pacific Telesis, and NYNEX, he was in charge of project management, product strategy, operations, and information management for a 150-channel broadcast digital television service.

After leaving Tele-TV, he established the Broadband Services Group, a Los Angeles-based management consulting firm, which provided strategic and business development advice to communications and media companies seeking to leverage emerging broadband technologies. He has also held positions at MCI Communications and McKinsey & Co. He holds a BA from Harvard College and an MBA from the Stanford University Graduate School of Business.

Andrew Luan
The Internet has changed the world, bringing instant access to the incredible amount of information available online whenever you are at your computer. Numerous connected devices are beginning to let you access the Web from an untethered device. The Geode Web Pad brings the full capabilities of a Web browser to a device that is convenient to carry and use wherever you are within its vast service areas. How will internet appliances change the way people interact with the Web, and what new products and services will spring up to cater to those who can utilize information "on the run?" Will medium bandwidth be sufficient or will rich media drive higher connectivity requirements?

As director of business development at Metricom, Andrew Luan identifies and works with strategic partners to create new services and opportunities. Previously, he served in product marketing and market development positions for companies in the e-business and interactive TV/data broadcasting/DTV industries, helping them launch new products and enter new industries. He spent four years as an analyst for the wireless telecommunication industry for RB Webber & Company. His studies included market entry strategies for Sprint, Airtouch, and PCSPrimeco. He received his BSEE from the Massachusetts Institute of Technology.

Gregory D. Abowd
There are many tantalizing possibilities associated with the growing adoption of small, networked devices. Indeed, Mark Weiser's decade-old vision of ubiquitous computing is slowly being realized from the device perspective. But his vision for "putting computing back in its place," out of the foreground of our consciousness and into the background of our peripheral awareness, is not necessarily being served by the proliferation of many different devices. I believe there will be no such thing as a "killer app" for ubiquitous computing that will encourage critical mass adoption of a single device for a single purpose.

I am a firm advocate of the pursuit of the "killer existence," in which an effective marriage of device capabilities and human-centered services helps to put computing in its place as a useful aid to our everyday lives. The research conducted by the Future Computing Environments (FCE) Group at Georgia Institute of Technology is aiming to overcome the research challenges to ubiquitous computing applications development. My personal interests lie in general problems of automated capture and access, context-aware computing, and natural-interaction techniques that scale the diverse set of emerging devices. This work requires an effective partnership between the purveyors of new device technologies and the developers of new ubiquitous-computing applications.

Gregory D. Abowd is an associate professor in the College of Computing and GVU Center at Georgia Institute of Technology. His research interests include software engineering for interactive systems, with particular focus on mobile and ubiquitous computing applications. He leads a research group in the College of Computing called the Future Computing Environments Group, which focuses on development of prototype future computing environments that emphasize mobile and ubiquitous computing technology for everyday uses. He received the degrees of MSc and DPhil in Computation from the University of Oxford, which he attended as a Rhodes Scholar. Before moving to Georgia Tech in 1994, he held post-doctoral positions with the Human-Computer Interaction group at the University of York and the Software Engineering Institute and Computer Science Department at Carnegie Mellon University.

Related Information

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www.metricom.com/ricochet_advantage/resource_center/Aberdeen.htm

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Future Computing Environments
www.cc.gatech.edu/fce

Game-Stories: Simulation, Narrative, Addiction

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Panelists
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Joystick Nation Inc.

Henry Jenkins
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Janet H. Murray
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Celia Pearce
University of Southern California

Ken Perlin
New York University

Eric Zimmerman
gameLab

From Monopoly to "The Sims" to improvisational theater, some of the most engaging media experiences ever produced have been described as "game-stories." We may sense that the holding power of the game-story is related to play, simulation, and narrative – but in general we aren't sure how. This panel takes the often vague idea of the game-story and pins it down to concrete examples. The panelists are game theorists, game designers, and game players. They ask if there is a middle ground between game and story, or if game-stories exist in a space of their own. They ask what makes the games we call "interactive narratives" work, and how we can make them work better.

J.C. Herz
One of the most useful tools for understanding the relationship between game and story is the concept of dimensionality. A cube, for instance, is a 3D object. Reducing its dimensionality yields a square (2D), a line (1D), and finally a point. Reducing the dimensionality of a film yields a still frame. Reducing the dimensionality of urban planning gives you architecture. Reducing the dimensionality of a game, by eliminating all but one of the possible trajectories through the world, yields a story. Essentially, the story is a core sample of the game: one trajectory through the universe of all possible solutions. Outside the system, that story might be dramatic or undramatic, just as the game itself might be satisfying or unsatisfying.

Dimensionality is not a good in and of itself. But the challenge for game designers, as storytellers, is to build a world that's interesting in multiple dimensions: the individual's trajectory through the world, the game as a whole (an overall sense of "gameplay" and dynamics), and the social experience that happens around the game (trading custom skins or levels, fan sites, etc.). Creating a satisfying experience is a more complex task in many dimensions than in fewer dimensions. Herein lies the challenge, for game designers and storytellers alike, as media evolve into more sophisticated, multilayered forms.

J. C. Herz is the author of *Surfing on the Internet: A Nethead's Adventures Online, Little, Brown & Company*. She has written for Rolling Stone, GQ, Wired, and Playboy. A native Texan now living in New York, her first Big Apple hack was crashing the Macy's Parade.

Henry Jenkins
The false dichotomy frequently drawn between stories and games stems from a too-narrow conception of story. Too often, we value classically constructed narratives over a broader range of storytelling traditions, including accordion-structure narratives (for example, Comedia Del'Arte) that depend on interplay between fixed elements and open improvisation, or spatial stories that focus on exploring or mapping worlds rather than recounting an event chain. Drawing on a comparative media studies perspective, I suggest continuities between games and a broader range of storytelling traditions. My discussion focuses on three recent Electronic Arts releases that demonstrate alternative approaches to integrating story and game: American McGee's "Alice," which draws on the player's preexisting familiarity with Lewis Carroll's universe; Clive Barker's "Undying," which embeds backstory within elements of the story space; and "The Sims," which provides a construction kit for players to create their own stories.

Henry Jenkins, director of the Comparative Media Studies Program at MIT, has spent his career studying media and how people incorporate it into their lives. He has published articles on a diverse range of topics relating to popular culture, including work on "Star Trek," WWF Wrestling, Nintendo games, and Dr. Seuss. He testified last year before the US Senate during the hearings on media violence that followed the Littleton shootings and served as co-chair of Pop!Tech, the 1999 Camden Technology Conference. Jenkins has published six books and more than 50 essays on popular culture. His books include *From Barbie to Mortal Kombat: Gender and Computer Games* (1999), *The Children's Cultural Reader* (1998) *What Made Pistachio Nuts: Early Sound Comedy and the Vaudeville Aesthetic* (1993), *Classical Hollywood Comedy* (1994), *Textual Poachers: Television Fans an Participatory Culture* (1992), and the forthcoming *The Politics and Pleasures of Popular Culture*. Jenkins holds a PhD in communication arts from the University of Wisconsin-Madison and an MA in communication studies from the University of Iowa.

Janet H. Murray
A compelling design problem for the next generation of story-game environments is creation of an experience for which I would propose the term "dramatic agency." Dramatic agency draws from two domains. First, it involves interactivity, which I have defined in Hamlet on the Holodeck as drawing on the procedural and participatory properties of digital environments. When both the computer's processing and the actions of the interactor are appropriately scripted, the result is the satisfying experience of agency. Secondly, dramatic agency draws on the domain of dramatic form and requires attention to the segmentation and granularity of events. My presentation draws on work done by students in the Information Design and Technology Program at Georgia Tech to demonstrate a range of approaches to dramatic agency.

Janet H. Murray is a professor in the School of Literature, Communication, and Culture at Georgia Institute of Technology, and director of the graduate program in Information Design and Technology. She is the author of *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* and the forthcoming *Inventing the Medium: A Principle-Based Approach to Interactive Design*, both from MIT press. She is a trustee of the American Film Institute and serves as a mentor in AFI's Exhanced TV Workshop. Before moving to Georgia Tech in 1999, she led humanities computing projects at MIT, where she remains a distinguished contributing interactive designer in the Center for Educational Computing Initiatives. She holds a PhD in English from Harvard University. Her research has been sponsored by the Annenberg/CPB Project, the National Endowment for the Humanities, the Andrew W. Mellon Foundation, IBM, and Apple Computer. She lectures and consults widely on the future of television, interactive narrative, and curriculum development for interactive design

Celia Pearce
The progress of interactive narrative is now in the throes of the evolutionary equivalent of a "small mammal explosion." The "warm-blooded" forms of narrative that are emerging are something halfway between game and story. They are both and yet neither, yielding entirely new forms that merge literature, game, cinema, and improvisational theater. Procedural narrative and collaborative narrative worlds have taken over from their more clunky forebears, such as so called "non-linear" narrative, hypertext, static navigational spaces, and puzzle games. These new experiences are dynamic, participative, and creative. In addition, they redefine notions of authorship as audience members begin to "take things into their own hands" and create, and in some cases trade and sell, their own characters and worlds. These emergent narratives and economies foreshadow a future where the current "narrative hegemony" of Hollywood is called into question by an increasingly interactive audience that has both the desire and skill to creatively partake in its own entertainment and narrative experience.

Celia Pearce is an interactive multimedia designer, artist, researcher, teacher, and author of *The Interactive Book: A Guide to the Interactive Revolution* (Macmillan.) She is a research associate at the University of Southern California's Annenberg Center for Communication and adjunct professor and production track-head of interactive media in the USC School of Cinema-Television. She has 18 years' experience as a designer of interactive attractions, exhibitions, and fine art projects. Past projects include: Iwerks and Evans & Sutherland's award-winning Virtual Adventures: The Loch Ness Expedition, a 24-player virtual reality attraction; the lounge@siggraph and The Virtual Gallery, a VR museum featuring walk-in paintings, both exhibited at SIGGRAPH 95; and Body of Light, an interactive performance piece that has been performed at the Electronic Cafe in Los Angeles and Canada's Banff Centre for the Arts.

Ken Perlin
Interactive character animation has focused mainly on animation, physical simulation, and rendering. Traditionally, behavior has been implemented by combining linear animation and motion capture. These techniques work reasonably well for interactive games, where the goal is mainly to explore worlds, gain points, kill enemies, and solve puzzles. But what if we want to go in the direction of interactive narrative – of an online drama or sitcom – of a game-story? In this case, we want to explore the personalities of the characters themselves. Is this possible or even desirable? How do we marry technology and content to find out? For audiences to buy into the believability and psychological presence of an interactive animated character, the whole notion of linear animation needs to be replaced.

Ken Perlin is a professor in the Department of Computer Science and director of the Media Research Laboratory at the Courant Institute of Mathematical Sciences of New York University. He is also director of the NYU Center of Advanced Technology, sponsored by the New York State Science and Technology Foundation. He completed his PhD in 1986 at the New York University Department of Computer Science. His dissertation received the Janet Fabri award for outstanding doctoral dissertation. He received his BA in theoretical mathematics at Harvard University in 1979. His research interests include graphics, animation, and multimedia. In 1991, he was a recipient of a Presidential Young Investigator Award from the National Science Foundation. In 1997, he was a recipient of a Technical Achievement Award from the Academy of Motion Picture Arts and Sciences for his noise and turbulence procedural texturing techniques, which are widely used in feature films and television. He was head of software development at R/Greenberg Associates from 1984 through 1987. Prior to that, from 1979 to 1984, he was the system architect for computer-generated animation at Mathematical Applications Group, Inc.

Eric Zimmerman
One of the difficulties in understanding the relationship between games and "interactive narrative" is that we lack a critical understanding of how they can be designed and deployed. Is every game a narrative? Are all narratives "at play" like a game? Isn't every narrative interactive in some way? If so, what do we mean when we use the term "interactive narrative?" Using plenty of audience participation, this panels looks at some non-digital interactive narratives, such as Choose-Your-Own-Adventure books and surrealist language games, as well as some of my own work, like the interactive paper book *Life in the Garden* and the multiplayer online game SiSSYFiGHT 2000. These examples sketch a taxonomy of narrative and interactivity that can help shed light on the new kinds of narrative experience that digital technology makes possible.

Eric Zimmerman is a game designer, artist, and academic. He is co-founder and CEO of gameLab, a New York-based game developer (www.gmlb.com). gameLab's first titles, BLiX and LOOP, are available on Shockwave.com. His pre-gameLab titles include the critically acclaimed SiSSYFiGHT 2000 (www.sissyfight.com, created with Word.com) and Strain (www.strainlab.com). His non-computer-game projects include the interactive paper book *Life in the Garden* (created with Nancy Nowacek and published in 2000 by RSUB); Organism, a board game published in ArtByte Spring 2000; and game installations in a variety of gallery and museum spaces, including Artists Space NYC. He has taught game design and interactive narrative design at MIT's Comparative Media Studies program, New York University's Interactive Telecommunications Program, and the Digital Design MFA program at Parsons School of Design. He is the director of RE:PLAY, a series of events about game design and game culture sponsored by Eyebeam Atelier. He has published and lectured extensively on the design and culture of play and games, and is currently co-authoring a book with Katie Salen about game design to be published by MIT Press in 2002.

Noah Wardrip-Fruin
Noah Wardrip-Fruin is a fiction writer, artist, and research scientist at the New York University Media Research Lab. He is currently the art and performance chair for DAC 2001 and an organizer of the art program for SIGGRAPH 2001, and he is editing *The New Media Reader* (forthcoming from MIT Press) with Nick Montfort and Michael Crumpton. His current fiction projects include a collaboration with a.c. chapman, Brion Moss, and Duane Whitehurst on The Impermanence Agent, a storytelling Web agent that customizes its story of impermanence for each user. This project was featured at SIGGRAPH 2000 and will appear this year in The Iowa Review Web, at a show curated by Harvestworks at The New Museum of Contemporary Art, and at the Brave New Word event at the Guggenheim Museum, New York.

Beyond Copyright: The Brave New World of Digital Rights Management

Moderator
Robert Ellis

Panelists
Dan L. Burk
University of Minnesota

Deborah Neville
Manatt, Phelps and Phillips

Barbara Simons

Sarah Stein
North Carolina State University

As more intellectual property (text, music, and images) becomes available in digital formats, there is increasing concern about protection of the material against unauthorized use and the sometimes-conflicting rights of the originators and users of the material. For example, intellectual property (IP) arguments about the use of MP3, the Secure Digital Music Initiative (SDMI), and the DVD Content Scrambling System (CSS) are currently receiving substantial coverage in the technical, business and popular press. Computer graphics professionals are discovering that they must be concerned with not only technical capabilities, but also policy and legal issues.

This panel addresses the following questions:

- Have new national laws (for example, the Digital Millennium Copyright Act) and international treaties (for example, the World Intellectual Property Organization) significantly altered the rights of IP owners and IP users?
- Will the use of digital copy protection systems such as CSS help or hinder acceptance of these devices by consumers?
- Is there a need for digital copy protection in broadcast and distribution of digital video?
- How does the traditional concept of fair use apply to digital forms of IP?
- How do peer-to-peer file-sharing systems such as Napster affect IP rights and fair use?
- Because much intellectual property is created by teams of people rather than a single author, what forms of IP ownership are appropriate?

Robert Ellis
We have been hearing a lot recently in the technical and popular media about digital rights problems. Unfortunately, we have heard the most from interested parties such as the Motion Picture Association of America (MPAA), the Recording Industry Association of American (RIAA), and the Home Recording Rights Coalition (HRRC). In addition, most of the rhetoric has addressed what can and should be done about accessing and copying digital material, and little has been said about the overall technical and legal issues. I believe it is time to hear from the people who are actually involved with producing and using digital works, academic experts, and practicing attorneys who can take a step back from the heated discussions and offer some practical comments on the problems.

Robert Ellis retired in 1993 as Sun Microsystems' representative on the Technology Policy Committee of the Computer Systems Policy Project (CSPP) and co-manager of Sun's university research program. Previously, he held computer graphics software development and management positions with Sun, GE-Calma, Atari, Boeing, and Washington University, where he received BS and MS degrees in electrical engineering and computer science. He currently serves as the chair of the Public Policy Program of ACM SIGGRAPH and is a member of ACM's U.S. Technology Policy Committee (USACM). He served as co-chair of SIGGRAPH 80, and he was a member of the SIGGRAPH Executive Committee from 1977 to 1983.

Dan L. Burk
Over the past decade, courts in the United States have firmly established that standard copyright doctrines such as those regarding fair use or joint authorship apply to digital media. However, the recently enacted anti-circumvention provisions of the Digital Millennium Copyright Act (DMCA) create a new right to control access to copyrighted works, separate from the exclusive rights under copyright. Such rights effectively endow copyright holders with a sweeping new ability to impose terms of access on content users. Consumers who access content without accepting the content owner's terms would be in violation. Even where a particular use would be permissible under copyright law, content owners may be able to exclude or license the use as a condition of access. Moreover, content that Congress is constitutionally forbidden from protecting as intellectual property is swept up into the scope of the DMCA provisions. The breadth of content control granted under these provisions not only far exceeds any treaty obligations that the DMCA was purported to fulfill, but also violates the constitutionally mandated limits on Congressional power to grant intellectual property rights.

Dan L. Burk joined the University of Minnesota faculty in the fall of 2000 as the Vance K. Opperman Research Scholar. He teaches in the areas of copyright, patent, and biotechnology law. His expertise is in the legal and societal impact of new technologies, including scientific misconduct, regulation of biotechnology, and the intellectual property implications of global computer networks. He holds appointments in both the Law School and the Center for Bioethics and currently serves as associate director of the new Joint Degree Program in Law, Health, and the Life Sciences. He has also been closely involved in the development of the new Internet Studies Center. Previously, he taught at Seton Hall University, George Mason University, Cardozo Law School, the Ohio State University Program at Oxford, and Stanford University Law School. He holds a BS in microbiology (1985) from Brigham Young University, an MS in molecular biology and biochemistry (1987) from Northwestern University, a JD cum laude (1990) from Arizona State University, and a JSM (1994) from Stanford University

Deborah Neville
Digital rights management of the arts is rising to the forefront with lawsuits such as the Motion Picture Association of America (MPAA) versus Scour. It is instructive to look to the music industry, which is embroiled in high-profile disputes over the right of consumers to share their music over the Internet, for a preview of things to come for visual art creators, tool developers, and various other rights holders. Given the inevitability of online

distribution, the music industry leaders' boycott of grass-roots efforts such as the Future of Music Coalition creates doubt as to the strategy of current rights holders who are ignoring the political voices of creators and technology developers. Provisions in copyright law that criminalize attempts to break through copyright control are viewed as threats to fair use. Will the economics be different in the areas of graphics works, visual arts, and tools? Will the economics encourage content lock-ups? How can creators best position themselves to create freely and derive their constitutionally created rights in the digital era? What will the economics of enforcement really be? Visual artists need to be aware and engaged to keep their freedoms from being eroded piecemeal by a patchwork of ill-conceived so-called protection measures predicated on misrepresented technological capabilities.

Deborah Neville's practice focuses on established and emerging high technology businesses and related intellectual property and business matters. She is senior counsel in the Palo Alto office of Manatt, Phelps and Phillips. Previously, she served as corporate counsel for both Hewlett-Packard Company and Agilent Technologies, Inc. While at HP, she headed the Entertainment Industry Strategic Initiative, creating business opportunities between the company and the media and entertainment industries. Most recently, she was vice president for legal affairs at Applied Science Fiction, a digital imaging company based in Austin. She received her JD from the University of California's Hastings College of Law and her BA in physics and biology from the Catholic University of America.

Barbara Simons

With the development of the World Wide Web, futurists predicted that vast libraries and entertainment resources such as movies, music, and games would be accessible from home computers. But much of the technology that makes it possible to access the Library of Congress from your living room also makes it possible to copy and distribute protected information for little or no cost. This fact was not lost on Hollywood and the record industry. Instead of a dream come true, they were experiencing a nightmare. The result of these fears was enactment of the DMCA. Not only does the DMCA threaten user rights of fair use and first sale, but also it does so by criminalizing technologies and technological devices instead of actual infringing behavior. Had such legislation been passed some years earlier, we might have found ourselves with no photocopying machines and no VCRs. In addition to the threat to future technologies posed by the DMCA, the anti- circumvention provisions, if they are taken literally, make many standard computer security techniques illegal. While no one intended to jeopardize our information infrastructure by passing such legislation, this is only one of some very serious potential side effects of the DMCA.

Barbara Simons was ACM President from July 1998 until June 2000. Earlier, she founded and chaired ACM's U.S. Technology Policy Committee (USACM) and chaired the ACM Committee for Scientific Freedom and Human Rights. She was elected Secretary of the Council of Scientific Society Presidents (CSSP) in 1999, and she has been on the CSSP Board from 1998-2000. She is a fellow of ACM and of the American Association for the Advancement of Science. She earned her PhD in computer science from the University of California, Berkeley, where her dissertation solved a major open problem in scheduling theory. Later, she became a research staff member at IBM's San Jose Research Center (now Almaden), where she did research on scheduling theory, compiler optimization, and fault-tolerant distributed computing.

Sarah Stein

Although for educators the notion of "edutainment" evokes an objectionable dumbing down of teaching and learning, there is a useful parallel to be drawn between the entertainment world and higher education. Producing motion pictures and developing computer-based curricula both rely on collaborative interactions between creative and technical teams. The media industry, which encompasses both film and television, has had to create models in which large numbers of personnel, at very different levels of creative input, can be compensated for their work. Thus the motion picture industry's template for compensation (both money and recognition) can provide higher education with a useful model. A more inclusive approach to intellectual property rights, responsive to the integral role of instructional technologists and designers, could benefit creative technical professionals in private industry as well as higher education.

Sarah Stein is assistant professor in the Department of Communication at North Carolina State University and a documentary filmmaker. At North Carolina State, she teaches courses in film, video, and digital production. She has also taught film editing at New York University's Tisch School of the Arts and presented visiting artist lectures at Sarah Lawrence College, Women in Film, Clark University, Hunter College/CUNY, AFI Film Seminars, and Villanova University. Her film work covers topics from social issues to music and art, with productions ranging from Bill Moyers and CBS to public television and independent documentaries. Among her many filmmaking awards are two Academy Awards for documentary editing, the Columbia-DuPont Journalism Award, several Emmy Awards and nominations, and numerous national and international film-festival awards. She has a PhD in media studies from the University of Iowa.

Art in Space: What For?

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D.A. Solomon

We are standing on the precipice of an emerging art form, Space Art, which is about people from different worlds working together, collaboration between technology and our biological carbon-based forms, finding terrestrial intelligence on earth as well as outside our own orbit, and eliminating the boundaries between art and science.

Should artists, visionary architects, writers, poets, and musicians be working in the space program? The closest artists have come to experiencing space travel is on parabolic flights that create the conditions of nearly zero gravity. Parabolic flights require a specially adapted aircraft and a highly specialized team: flight crew, trained instructors, and physicians. They are undertaken by a handful of space agencies specifically for astronaut training and scientific experiments. During the flights, bodies and objects inside the aircraft float freely for 25-30 seconds. A flight can have between 10 and 40 parabolas. Many people experience severe discomfort and sometimes euphoria in zero gravity.

Emerging artists are realizing that the tools, materials, and activities used by space scientists and astronauts could provide new materials and media for their work. Artists-astronauts in converging spaces are expanding into new realms of art practice by creating socially "holistic" endeavors. An underground movement of American artists has collaborated with the National Aeronautics and Space Administation (NASA) officially and unofficially, for 25 years, and a few artists are now exploring these media. In 1999, the British organization Catalyst Arts and the Slovenian Ministry of Culture provided financial support for theater and dance performances in micro-gravity training aircraft in Russia's Star City. Recently, a team from the San Francisco Art Institute (the only art school in the world to be involved in this type of research) flew the "weightless wonder" as part of NASA's Reduced Gravity Flight Opportunity Program. This has inspired a revival of new space art in California and established a new role for the United States in the "space art race." It has also raised a critical question: Who will be the first artist in space?

Assuming that a real space age finally does arrive, at some point later in the 21st century as new technologies make it cheaper to achieve escape velocity, it will also start to rely heavily on a familiarity on the part of the audience with weightlessness. The more people grow familiar with the radically altered sense of space and time that weightlessness can bring, the more they'll also be ready intuitively to understand the imperatives behind the expanded viewpoints onto reality that the zero gravity arts will create.

> What is the state of weightlessness? In future decades, we'll integrate the presence of inhabited interplanetary stations. This existence of new places will become a new dimension in our cultural consciousness and in our philosophical dimension.
> *Michael Benson (filmmaker who documented the "Noordung" Theatre performance in zero gravity)*

Ted Krueger
The rigors of high-performance aircraft and space vehicles have led to sophisticated sensing and control technologies, and techniques for imbedding sensors in structural components. A comprehensive biological model for architecture may develop out of research into sensing, active control systems, and interactive materials developed in the aerospace and defense industries during the last decade. The locus of design shifts away from the form to concentrate on the behaviors and the interface that will be required for intelligent and interactive environments. Technology is something independent, on its own developmental trajectory, that could overtake and surpass human development. It may be that we are in a feedback loop with the products of our culture. We experience them within a kind of perceptual Doppler effect. They develop and go out as extensions of our selves and return to us, subtly shifted, as an Other. What could be the consciousness of an architectural artifact modeled on biological phenomena?

The implications of these technological developments are to fundamentally alter our relationship with the products of material culture. Autonomous, adaptive, and interactive environments are no longer physical only, but participants in the social realm as well. This fundamental shift, though founded on technological development, is a cultural operation and points to the need for participation of cultural workers with the technological disciplines.

Marco Peljhan
Artistic and scientific practices have one common ground: they are both creative behaviors that push and explore unknown territories. Now that the International Space Station is in orbit, it must host not only scientific and commercial components, but also superlative spiritual work. If it does not, there will be a problem for the future of the station and for humankind.

Marko Peljhan set up Makrolab, an art-science autonomous research station resembling the Mir Space Station. It was first shown at Documenta in 1997 and then on the remote Rottnest Island off Australia. He intends eventually to install Makrolab in Antarctica. He founded the arts organization Projekt Atol in 1992 and its technical branch Projekt Atol Communications Technologies (PACT Systems) in 1995. He is the co-founder of the Ljubljana Digital Media Lab (LJUDMILA) and coordinator of the Makrolab and Insular Technologies projects. In 1999 and 2000, PACT worked with the Yuri Gagarin Cosmonaut Training Centre to organize four arts-based parabolic flights, three for the Slovenian Noordung team and one in cooperation with Arts Catalyst for the Franco-British parabolic flight of Kitsou Dubois.

D.A. Solomon
In the past, artists have been excluded from space exploration. During the year 2000, artists and selected individuals gathered to repair this faulty piece of history. They met in a newly installed space at the Stedelijk Museum to design a mission to the International Space Station. The goal of this mission is to optimize conditions for integrating artists into space exploration programs. Current space-program protocols do not provide much room for the creative process that both artists and scientists need to fuel their work. So far, space has been the sole domain of technicians and the military. One of the purposes of the artist-astronaut video document is to issue a strong proposal to NASA and the European Space Agency that shows how a mission can be modified to optimize the creative process and how doing so will be valuable to the scientific process.

Lorelei Lisowsky
With the onslaught of our technological age, we continue to be devoured and obsessed with "machinic" transportation and the need to be released from our condition of "gravity." Current trends in social and technological developments speak about the transcendence of our bodies and adjustment of the body in zero gravity. When we enter zero gravity, the first thing that occurs is loss of the brain's logical functions. The second thing is loss of the sense of having a body and awareness of "existence" only (a pure feeling). The body self floats, gravity is gone, and subversion of the vertical gives us a state of being that borders on the divine. This begins the next step of evolution. We cope and explore the greater need, separation, and expansion.

In our experiment on the KC135, we explored human-computer interaction in micro gravity. Through close examination of the data-processed phantasm, movements and flows of the visible and invisible body are given access to visual qualities as well as interpreted in a numerical formula. By interfacing the technological being with the need to escape gravity, transformation of perceived orientation within physical and virtual space can be monitored and scanned to describe multiple dimensional positions and occurrences.

Now is the time to ask the relevant people to explain to the world: why not artists in space?

As a public artist and through her involvement with the Exploding Cinema in London, Lorelei Lisowsky experiences the power and potential of social interaction. Her recent parabolic flight was a life-changing experience.

Noordung performing artists in microgravity aircraft flights.

Virtual Stars

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Think of the greatest performances of our time. They are all products of fertile imaginations and great collaborative efforts of many talented individuals. But are their persistent effects "real" or ephemeral? Some of the most enduring characters, the most unforgettable, most indelible performances, live not in real life but in our emotional connections to them

In this Special Session on visual effects, artists from Sony Pictures Imageworks and Rhythm & Hues Studios draw from their repertoire of characters and productions to explore the creative and technical process of bringing characters to life. Their ability to create dynamic digital characters, imbue them with personality and photo-realistic characteristics, and thoroughly and seamlessly integrate them into live-action stories dramatically expands the filmmaker's boundaries. Actors are no longer constrained by the physical limitations of their being. Gravity, strength, and logistics can be defied. Animals can speak. Villains can be unspeakable.

"Stuart Little," "Babe," "Hollow Man," "The Flintstones," and the upcoming productions of "Spider-Man," "Cats & Dogs," "Harry Potter and the Sorcerers Stone," and "Stuart Little 2," display increasingly advanced examples of how digital artists transform the fabric of filmmaking.

Success in creating these performances is a combination of art and science. Mastery comes in the blend of style and technique. In this session, participants explore digital characters through story and character development, art and design, animation and digital production, and technology.

Sony Pictures Imageworks is an award-winning, state-of-the-art visual effects and animation company dedicated to the art and artistry of digital production. It has grown from a small team of artists and producers to a thriving company of over 380 full-time employees in a state-of-the-art facility. It has received three Academy Award (nominations for "Starship Troopers," "Stuart Little," and "Hollow Man") and countless industry merits and awards. Its work has been a major part of numerous features including: "Contact," "Starship Troopers," "Anaconda," "Godzilla," "Patch Adams," "Stuart Little," "What Lies Beneath," "Hollow Man," "Cast Away," and "Charlie's Angels." Current projects include " Harry Potter and the Sorcerers Stone," "Spider-Man," and "Stuart Little 2."

Founded in 1987, Rhythm & Hues Studios is a leading producer of character animation and visual effects for the entertainment industry. In 1995, Rhythm & Hues was honored with the Academy Award for Best Visual Effects for its work on "Babe." Work from the Rhythm & Hues Feature Film Division can be seen in a wide variety of recent films including "Along Came a Spider," "Bedazzled," "How the Grinch Stole Christmas," "Little Nicky," "The 6th Day," "Red Planet," and "Rugrats in Paris." Currently, Rhythm & Hues is in production on "Cats&Dogs," "Dr. Dolittle 2," and "The Sum of All Fears."

Masters of the Game

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Winners of the Academy of Interactive Arts and Sciences Interactive Achievement Awards for excellence in: art direction, animation, game play engineering, visual engineering, sound design, musical composition, and character and story development.

Hosted by J.C Herz of Joystick Nation Inc., with an introduction from the president of the academy, Paul Provenzano, Masters of the Game offers a behind-the-scenes look at some of the world's leading games and the people who created them. The award winners will speak about the games, their sources of inspiration, their multi-disciplinary teams, and how they created the magic for which they won the AIAS Interactive Achievement Award.

Outstanding Achievement in Sound Design and Musical Composition

Medal of Honor: Underground (PlayStation)
DreamWorks Interactive/Electronic Arts

Lead Manon from her beginnings in the resistance through her recruitment by the OSS to thwart the German onslaught. Armed with an arsenal of new weapons, you battle tanks, half-tracks, and Gestapo thugs across Europe and North Africa. From the cobblestone streets of Paris to the narrow alleyways of Casablanca, from a doomed Italian monastery to Himmler's dark medieval castle in Germany, you undertake challenging missions to outwit and outgun fierce enemy troops. Procured weapons, expert stealth, and a poised trigger finger – you'll need them all to become a seasoned veteran of the OSS and return home to take part in the liberation of your homeland.

Speakers
Erik Kraber, Jack Grillo, Michael Giacchino

Erik Kraber, Jack Grillo
Erik Kraber and Jack Grillo are the lead sound designers for DreamWorks Interactive. Their work on the Medal of Honor series and Clive Barker's Undying has resulted in many accolades, including two AIAS Craft awards for Best Sound Design of the Year. They both began their careers designing sound for films and commercials before joining DreamWorks Interactive.

Michael Giacchino
In early 1997, Michael Giacchino was approached by the newly formed DreamWorks Interactive to score their flagship PlayStation video game based on Steven Spielberg's summer box office phenomenon, "The Lost World." The result was the world's first ever completely original orchestral score written for a PlayStation console. Since then, he has composed six additional orchestral scores for DreamWorks Interactive. Last summer, he recorded his score for Medal of Honor: Underground, which garnered him the AIAS craft award for best achievement in musical composition, and in March of this year, he began composing the music for the next chapter in the DreamWorks Interactive Medal of Honor series, which goes before the orchestra in June.

Outstanding Achievement in Visual Engineering and Game Play Engineering

SSX: Snowboarding Super Cross (PlayStation 2)
Electronic Arts/Electronic Arts

Explode out of the gate and launch into the race of your life. Push the boundaries of real physics to dominate the SSX World Circuit. This high-speed arcade racer revolutionizes snowboarding games by taking the sport and tricks of today onto the tracks of tomorrow. Enter mind-blowing worlds with spectacular tracks, while listening to break-beat music that mixes on the fly. Experience full-contact survival-mode racing that keeps you riding the edge between control and chaos.

Speaker
Mike Rayner, Electronic Arts

Mike Rayner has been an active member of the game development community since 1994. He holds both a bachelors of engineering and a bachelors of science from the University of Western Ontario. After distinguishing himself in the R&D group at Gray Matter, he joined Electronic Arts in October 1997. Previously the lead rendering programmer on SSX, he is currently lead platform engineer on the upcoming sequel.

His game credits include: Foes of Ali Boxing (3DO), Perfect Weapon (PSX+PC), The Crow City of Angels (PSX+PC), Manic Marbles (PC), The Condemned (PC), Triple Play 1999 (PSX+PC), Triple Play 2000 (PSX+PC), and SSX (PS2).

Screen Shot from SSX: Snowboarding Super Cross.

Outstanding Achievement in Game Design

Zelda: Majora's Mask (Nintendo 64)
Nintendo Co. Ltd./Nintendo of America

Thrown into a parallel world by the mischevious actions of a possessed Skull Kid, Link found a land that was in grave danger. The dark power of a relic called Majora's Mask had wreaked havoc on the citizens of Hyrule, but their most urgent problem was a suicidal moon crashing toward the world. Link had only 72 hours to find a way to stop its descent, so he traveled through time and worked ceaselessly until he accomplished his goal.

Speaker
Ken Lobb, Nintendo of America Inc.

Ken Lobb is director of game evaluation and marketing support for Nintendo of America. Over the years, he has designed and produced games such as Low-G-Man and G.I. Joe for the NES; Rolling Thunder 2, Splatterhouse 3, and Wings 2 for Genesis and Super NES; Killer Instinct, Tetrisphere, Goldeneye, Perfect Dark, and Conker's Bad Fur Day for the arcade and Nintendo 64. Prior to joining Nintendo in 1993, he worked as a product manager for Namco Hometek and Taxan USA and as a product/test Engineer for AMD and Waferscale Integration, Inc. Currently, he is working on projects for the Nintendo GameCube and still loves his job and hobby.

Outstanding Achievement in
Character or Story Development
Baldur's Gate II (PC)
Interplay Entertainment, BioWare Corp.

Every world has conflict. Good and evil. Friend and foe. Safety and danger. In Baldur's Gate II: Shadows of Amn, you find yourself between these factions. This epic sequel immerses you in a world of intrigue, adventure, and fierce combat, where your ability to discern the difference between these sides (with the assistance of steel and spell) determines your fate.

In Baldur's Gate I, you defeated your evil half-brother, Sarevok, and prevented your father, Bhaal, the dead Lord of Murder, from returning to the Forgotten Realms. Now, in Baldur's Gate II: Shadows of Amn, the stakes have become much higher. Will you resist the evil within you and forge a legend of heroic proportions? Or will you embrace your monstrous inner nature, and carve a swath of destruction across the realms?

Your story begins anew in the exotic southern kingdom of Amn, amidst the opulence of the sinister capital city of Athkatla. Journey through the fierce, unforgiving wilderness of Amn and the treacherous caverns of the Underdark in your quest for artifacts of awesome power and treasure of inestimable wealth. Even challenge dragons, if you dare. Such is the life of a legend.

Speaker
David Hibbeln, Director of Art, BioWare Corp.

Ever since he was a wee lad, David Hibbeln loved to draw, play computer games, and play Dungeons & Dragons, but never dreamed it could be made into a career. As a somewhat older lad, he went to the University of Alberta and graduated with a BA in linguistics and a minor in English. It was there that he learned the finer points of written and oral communication, but his love and passion for art drove him to pursue visual communication. His interest in comic art prompted him to try self-publishing comics. He also did some freelance graphic design work before he was drawn to the beauty and emotion of animation as a visual communication medium. His love of animation and film prompted him to take as many courses and read as many books on animation as he could find.

His first animation work was as assistant animator on a National Film Board of Canada short animation called "Cactus Swing," at Salamander Studios in Edmonton. After that film was complete, he had an opportunity to learn computer animation at a local company. From there, the rare opportunity came to join a new computer-games company: BioWare Corp. He saw this as an opportunity to bring better animation to computer games. As BioWare grew, he formed an animation department at BioWare to specifically meet the challenges of all things moving in a game. Currently, he is director of art for BioWare, where he manages a growing pool of 35 artists. He is also still involved in production, directing the cinematic elements and advising on in-game animation.

Paul Provenzano
Paul Provenzano is president and executive director of the Academy of Interactive Arts & Sciences, the professional academy of the $6.1+ billion interactive entertainment software industry. He is a 10-year veteran in interactive entertainment with 18 years overall in the entertainment industry.

J.C. Herz
One of the most useful tools for understanding the relationship between game and story is the concept of dimensionality. A cube, for instance, is a 3D object Reducing its dimensionality yields a square (2D), a line (1D), and finally a point. Reducing the dimensionality of a film yields a still frame. Reducing the dimensionality of urban planning gives you architecture. Reducing the dimensionality of a game, by eliminating all but one of the possible trajectories through the world, yields a story.

Essentially, the story is a core sample of the game, one trajectory through the universe of all possible solutions. Outside the system, that story might be dramatic or undramatic, just as the game itself might be satisfying or unsatisfying. Dimensionality is not a good in and of itself. But the challenge for game designers, as storytellers, is to build a world that's interesting in multiple dimensions: the individual's trajectory through the world, the game as a whole (an overall sense of "gameplay" and dynamics), and the social experience that happens around the game (for example, trading custom skins or levels, fan sites, etc.). Creating a satisfying experience is a more complex task in many dimensions than in fewer dimensions. Herein lies the challenge, for game designers and storytellers alike, as media evolve into more sophisticated, multilayered forms.

Web3D RoundUp

Timothy Childs
RoundUP Productions and Eyematic

The Web3D RoundUP lives somewhere between classical art and commerce. In the SIGGRAPH context, the RoundUP lives within the nexus between the commercial-oriented Exhibition, the bleeding-edge technology of Emerging Technologies, and the Art Gallery.

Now one of these worlds has dramatically changed the balance. As the swooping pendulum of current market conditions swings toward economic practicality, consolidation and shakeout in the Web3D industry is in process. Now that the installed computer base is actually fast enough for Web3D technologies, major software developers will move into the 3D Web. Pure content "plays" are dead. Just like everyone else, Web3D companies must now seriously start to justify themselves by carving out sustainable ways of staying in operation. Evolve or die! Signs of evolution in Web3D emerge to make real businesses out of creativity, including communications, wireless, and online gaming.

With the emergence of business-based themes that leverage the tools and talents of Web3D, mergers for survival are happening. Quietly, behind the scenes, big software companies have been acquiring enabling technologies, and they are rolling out their solutions at SIGGRAPH 2001. And looming on the horizon is a rapidly growing trend of using easy-to-create avatars (yes the once dreaded "A" word) as a communication medium, representing people across a myriad of networks and devices.

And then there is wireless. (Doesn't everyone have a wireless strategy?) Web3D's role in the emerging wireless field will be bleeding-edge, interesting, and provocative. Unlike bandwidth-clogging video, Web3D is a natural for low-bandwidth wireless networks. Now that 3D-enabled wireless devices are coming to market, depending on where you live, you can soon expect a swarm of 3D characters and applications to be playing on a mobile device near you.

And if there was ever a killer app of Web3D, it would be online gaming. Massive-player online games have revolutionized how content, technology, art (creation and asset management), and financial models are conceived.

The Web3D RoundUP, has been showing the hottest and most bleeding-edge technology for years. We've strived to spur creativity and show you the best of the best. Especially now, the Web 3D RoundUP's goal is make sure that creativity is not lost in this age of business, to help blend technology, creativity, and art in a way that benefits us all in many ways, including financial.

Web3D RoundUP must evolve as well. Prior to SIGGRAPH 2000's boisterous event, we responded to feedback that the "negative sound" devices ("moo canisters") really didn't work that well compared to the happy "wacka wacka" sound devices. So we experimented with the rubber "razzer." It turned out to be much more effective than anticipated. The noisemakers really created a much more raucous feedback session than we had ever seen. So we are on a quest for the perfect noisemaker: not too quiet and not too loud.

About the Web3D RoundUP

The Web3D RoundUP is a high-speed shootout that showcases the latest and very greatest interactive 3D content available over the Web. Diplomatically, we describe this as an "interactive event for interactive content." Realistically, it can be a gut-wrenching monster. Have you ever tried doing a cool demo in less than three minutes, with the seconds ticking down on the big screen, in front of thousands of world-class graphics experts, all armed with happy/sad sound effects and ping-pong ball blasters!

Twice a year, at the annual SIGGRAPH conference and Web3D200x, the Web3D RoundUP presents the best the Web3D world has to offer in a cool and entertaining way. The challenge for jurors is to choose two dozen diverse, eye-popping selections from nine dozen submissions. The challenge for presenters is to first finish that killer demo, and then engage the audience in a fun way so that everyone can interactively participate and become part of the event itself. The challenge for the audience is to hold on without blinking during this wild ride, to shake and rattle various "interactive feedback devices" for live comment, and then vote to pick the entry in each category that deserves to receive a coveted "Golden Lasso."

The Web3D RoundUP evolved from the early days of the Virtual Reality Education Foundation (affectionately known as VeRGe), which was created by Timothy Childs, Linda Jacobson and Peter Rothman. Another precursor was the first SIGGRAPH Demo SIG meetings organized by Don Brutzman, where the VRML community kick-started Web-based 3D graphics. It was through those early VeRGe and Demo SIG events that we got our first tastes of technically successful chaos, which morphed into today's Web3D RoundUP. Each year, we continue to grow, adapt, tumble, and evolve as presenters push the limits.

One of the things that gave the Web3D RoundUP its original kick was the oft-occurring computer crash. There seemed to be a direct correlation between a crashing computer and how bleeding-edge the demo was. Now Web3D technology is starting to stabilize (and fewer virtual fire extinguishers are needed). Even so, we're still seeking the bleeding edge.

The Web3D RoundUP became what it is today thanks to great help from all the amazing volunteers at both SIGGRAPH and Web3D conferences, as well as the solid advice and support by many SIGGRAPH chairs, staff, committee members and student volunteers. We're especially grateful and blessed to see some of the same faces return year after year to help out in the days of temporary backstage chaos as we prepare for the event. Thank you all. We are most fortunate to receive sage guidance from the world's greatest audio-visual wizards at (where else!) AVW Audio Visual. Finally, we thank the hardworking technical trapeze artists and content creators, who put in countless hours getting ready for just a few minutes of unforgettably intense glory on stage.

Sensapalooza: Guided Tour of the New Silicon Senses

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Aerome USA

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Human beings are embedding computer chips in their bodies to enhance, extend, or repair their senses, while computers are gaining the ability to see, hear, smell, taste, and touch. And once a computer has its own sensorium, it's conceivable that it could at some point learn to think.

This remarkable convergence of body and machine is empowered by merging advanced computing technology with the human nervous system, a combination that holds could restore sight to the blind and help victims of paralysis regain partial use of their limbs. The flexh-chips convergence is also giving individuals bionic senses, such as the ability to see infrared radiation or to feel objects at a distance. Some futurists even suggest that computers will eventually enable extra-sensory perception.

This Special Session is a combination of talk show and television cooking program, with a Greek chorus attached. Six guests (one for each of the five senses and one for the sixth sense, mind) demonstrate leading-edge technologies that show how the human sensorium is being augmented with sophisticated computer chips. During and after the demos, members of the Greek chorus contribute their own observations and comments. The audience participates by entering questions on the Special Session Web site via wireless network connections.

The goal is to provide a compelling and provocative overview of some of the newest technologies that could soon become part of our computers and our bodies.

Sight

Picture this. You are walking down a street in a foreign city, wondering how to find a particular restaurant, where you've arranged to meet an old friend. When you enter a few commands in a small computer attached to your belt, a map of the city appears in the air before you, and you notice that the quickest route to the restaurant is outlined in yellow. When you find the right street, you can't quite make out a sign in the distance. A light touch to your glasses magnifies the image, confirming that this is indeed the restaurant. You enter the restaurant and recognize your friend at a table. And now picture one more thing: You are legally blind. This scenario is far from improbable. In fact, it's already a reality. Visual prosthetics (electronic implants in the eye, the optic nerve, or the brain) are enabling blind people with certain eye diseases to see again, and retinal displays can project virtual images directly into the eye. These technologies are bringing new dimensions to the sense of sight that could provide eyes in the back of your head and the ability to see things beyond the normal visible spectrum.

Hearing

Voice operation and speech synthesis are increasingly commonplace in mobile phones, automobile navigation systems, and other devices in which portability and ease of use are key. Research is even under way to replace familiar desktop icons with "earcons," audible tones that would alert users to incoming email, changes in stock prices, or important news bulletins.

For mobile devices, this technology would allow users to keep their eyes on the road, the sidewalk, or other travelers instead of casting furtive glances at a computer screen. A travelling day trader could hear the steady murmur of the Dow, for example; when it goes up, perhaps the earcon is a high-pitched squeal of fireworks; when it goes down (who knows?), perhaps the sound of a flushing toilet. The abilities of computers to hear and parse human speech are being put to use in portable devices that provide real-time translations within certain domain-specific subject areas. Other research is dedicated to improving hearing by making the cochlear implant even more like the biological system it emulates. Researchers are finding that the best way to try to match what the senses can do is to study the biology and then replicate key computational concepts in electronics.

Smell

Electronic noses, arrays of odor-sensitive electrochemical sensors linked to high-powered computers have been in use for several years, primarily to trace explosive residues, analyze blood alcohol levels, and carry out quality control tests in the food and beverage industries. A new generation of e-noses is beginning to replicate the speed, sensitivity, and discrimination of the human nose. Soon, a digital proboscis will be able to do everything from assist in medical diagnoses to identify leaks of hazardous substances. Thanks to these new engines of olfaction, your family physician may soon be developing a preliminary diagnosis based on information gleaned from an electronic nose in your phone.

Computers can also pass gas. Firms in the US, Europe, and Israel have developed technology that is, in effect, a video player for the nose. When you insert a scent cartridge (a white rectangular box that looks very much like an ordinary video cassette but contains six prefabricated scents) into one of these devices, it releases appropriate aromas in sync with scenes from a video or

film presentation. These firms claim that they can create any desired fragrance, and that the amount, intensity, and duration of the smells can be precisely controlled. Fragrant Web stes, scented emails, odoriferous interactive games, and aromatic online advertising may be coming soon to a computer screen near you.

Taste

Companies and research labs are developing electronic tongues that can sample foods, beverages, and even blood. At least one firm plans to deliver fast food over the Internet, which means that die-hard geeks might one day never have to leave their desktops, not even to order pizza. Using technology similar to the scent controller described above, this machine works like a gustatory fax; it transmits a message to the user's computer in response to a click on a taste-enabled Web site. From this message, a miniature kitchen attached to the user's computer then whips up the appropriate flavor. Some researchers imagine the day when miniature taste-sensor technology will be attached to the ends of chopsticks and spoons. Dip your chopsticks into a meal, and they will not only tell you what you are eating, but also list the ingredients and provide you with the recipe. Back home in your Internet-enabled kitchen, just plug the chopsticks into the fridge, and the fridge will call up the recipe on the screen and order any missing ingredients.

Touch

Technology is getting onto, and under, our skin. Computers are moving off the desktop into everyday objects, and human bodies, putting people "in touch" with technology in an ever-more-intimate embrace. Physicians are implanting electrodes into patients to rehabilitate atrophied muscles, prevent epileptic seizures, and restore motor function lost as a result of paralysis. Engineers are creating hybrid prosthetics such as ankles, legs, and knees in which silicon chips are melded with living tissue. Computer scientists are designing haptic (from the Greek word meaning "to touch") interfaces that allow users to reach out and touch digital information, transforming the plain old graphical user interface into a graspable user interface. By coupling digital information with everyday objects like tabletops, appliances, and coffee cups, the physical world is becoming one enormous interface.

Mind

Since bodies are essential to the emergence of mind in human beings, it makes sense to assume that artificial creatures need bodies, too, if they are ever to become aware, intelligent, and, perhaps someday, even conscious. The rallying cry for this kind of research might be summarized in a slogan: "No sensation without representation." Computer scientists are providing physical representations for these possible minds by taking Alan Turing's advice: give machines – both virtual ones inside computers and physical ones in the form of robots – the best sense organs that money can buy. Researchers are also growing neurons on silicon chips to create the ultimate man-machine interface, one that could help victims of neurodegenerative brain disorders and empower electronic devices that can be operated by thought alone.

James Geary–TIMEeurope.com
James Geary is editor, special projects at TIMEeurope.com. He has written a dozen cover stories on subjects as diverse as language extinction, the neurological basis of memory, and the attempts of European politicians to create a "Third Way." He has edited three Time special issues – "The New Age of Discovery" (1997), "Visions of Europe" (1998), and "Fast Forward Europe" (2000) – as well as special reports on telecommunications, technology, and the Internet in Europe. He won Time Inc.'s President's Award, granted in recognition of excellence in generating ideas and delivering results, for the "Visions of Europe" special issue.

In June 2000, he won the NetMedia 2000 European Online Journalism Award for science with his article "What Is Life?" which explores one man's research in the field of artificial intelligence. In his spare time, he regularly contributes book reviews to the James Joyce Quarterly. He also composed the libretto for the dramatic song cycle, "Broken English," which premiered in Amsterdam in August 1997. His book about computers and the human senses, The Body Electric: An Anatomy of the New Bionic Senses, will be published by Weidenfeld & Nicolson in the fall.

Kathryn Saunders
Kathryn Saunders is a founding partner of ThinkTech, a consulting firm that designs and develops location-based and e-based experience strategies. She has been actively involved with SIGGRAPH for many years. She is Panels Chair for 2001, and for SIGGRAPH 99, she chaired Emerging Technologies, where she developed and executed the Millennium Motel concept and curated several elements including the entry portal and Route 66.

Trained as an architect, she practiced architecture with two of Canada's leading design firms and has taught architecture at two Canadian universities. Prior to her current post, she was executive director of the Digital Media Institute and creative director, digital media, at the Royal Ontario Museum. At the museum, she developed MYTHICA, an educational entertainment destination that uses a profiling system, wireless technologies, and intelligent autonomous agents to deliver personalized information before, during, and after a visit, based on the visitor's behavior and aspirations. A recipient of many interactive media awards, she has consulted and lectured around the globe from North America to Saudi Arabia and Japan.

Ferdinando (Sandro) Mussa-Ivaldi
Sandro Mussa-Ivaldi is a faculty member at the Medical School of Northwestern University. He holds appointments with the departments of physiology, physical medicine and rehabilitation, biomedical engineering and mechanical engineering.

Originally from Turin, Italy, he received a graduate degree in physics from the University of Turin and a PhD in biomedical engineering from the University of Genova and the Polytechnic of Milan.

His past teaching and research credits include:

- The University of Provence, where he worked with Gabriel Gauthier on coordination of eye and hand movements.
- The department of computer science of the University of Genova as a research fellow, where he worked with Pietro Morasso on computational models of handwriting.
- MIT, where he collaborated with Emilio Bizzi and Neville Hogan on a number of studies aimed at understanding the interplay of neural, mechanical, and computational factors in the control of arm movements.

A significant portion of his research is conducted within the Sensory Motor Performance Program of the Rehabilitation Institute of Chicago. His current studies is the focus on the mechanisms underlying the ability of the central nervous system to learn new movements and to adapt previously learned movements to changes in the body as well as in environmental dynamics. Current knowledge indicates that the brain learns new patterns by establishing long-term modifications in the ability of nerve cells to exchange information with each other. Recently, his research team developed a hybrid system that establishes a bi-directional interaction between living neural tissue and a simple mobile robot. They are trying to exploit the behaviors that emerge from this interaction as a window into the information processing of the brain tissue and, in particular, on the mechanisms of synaptic plasticity.

Henri Lustiger-Thaler
Henri Lustiger-Thaler has been associated with Aerome Scent Communications since the founding of the Company in 1997. He received his doctorate from Université de Montréal, completed his post-doctorate work at Cambridge University, and has been a visiting fellow at Dartmouth College and the University of Rome at La Sapienza. He has published several books and numerous articles on culture and global communication. He is considered to be the foremost specialist on scent communications in the world today.

Thomas A. Furness III
Thomas A. Furness III is a pioneer in virtual interface technology and virtual reality. He received a BS in electrical engineering from Duke University and a PhD in engineering and applied science from the University of Southampton. He is currently professor of industrial engineering and adjunct professor of electrical engineering and technical communication at the University of Washington, and is the founding director of the university's Human Interface Technology Laboratory. Prior to joining the University of Washington, he served a combined 23 years as an officer and civilian at the Armstrong Laboratory at Wright-Patterson Air Force Base, where he developed advanced cockpits and virtual interfaces for the US Department of Defense. He is the author of the Super Cockpit program and served as the chief of visual display systems and Super Cockpit director until he moved to Seattle in 1989.

The overall mission of the Human Interface Technology Laboratory is to empower humans by building better interfaces to advanced machines that will unlock the power of human intelligence and link minds globally. The HIT Lab consists of 120 faculty members, professional staff, students, and visiting scholars. It is supported in part by the Virtual Worlds Consortium, a group of 47 companies that provide funding and in-kind annual contributions to the laboratory's research agenda. The laboratory's work encompasses development of hardware and software technologies, human factors, and applications development associated with advanced interfaces with a focus on virtual reality.

Hiroshi Ishii
Hiroshi Ishii's research focuses on design of seamless interfaces among humans, digital information, and the physical environment. At the MIT Media Lab, he founded and directs the Tangible Media Group, which is pursuing a new vision of human-computer interaction: Tangible Bits. His team seeks to change the "painted bits" of graphical user interfaces to "tangible bits" by giving physical form to digital information:

From 1988 to 1994, he led a research group at the NTT Human Interface Laboratories, where his team invented Team-WorkStation and ClearBoard. In 1993 and 1994, he was a visiting assistant professor at the University of Toronto. He is actively engaged in research on human-computer interaction and computer-supported cooperative work. He served as associate editor of ACM TOCHI (Transactions on Computer Human Interactions) and ACM TOIS (Transactions on Office Information Systems). He also serves as a program committee member of many international conferences including ACM CHI, CSCW, UIST, SIGGRAPH, Multimedia, Interact, and ECSCW. He received a BE in electronic engineering, and ME and PhD degrees in computer engineering from Hokkaido University.

Ellwood Ivey
Ellwood Ivey attended the School of Business at Savannah State College and completed the Sales and Marketing program at Draughons Business College. His many accomplishments include building a 92-member sales team for a major international health food company. He has served as a technology consultant to Hoechst Celenese Corp., a $16 billion conglomerate. In 1991, he founded the D.U.I.E. Project, managed development of its revolutionary technology (hydrocarbon specific sensor), and facilitated its joint venture and licensing deal valued at nearly $10 million. He currently holds four patents, two service marks, two trademarks, numerous copyrights, and other proprietary properties.

Alex Waibel
Alex Waibel is professor of computer science at Carnegie Mellon University and Universität Karlsruhe. He directs the Interactive Systems Laboratories at both universities, where his research emphasis is in speech recognition, handwriting recognition, language processing, speech translation, machine learning, and multimodal and multimedia interfaces. At Carnegie Mellon, he also serves as associate director of the Language Technology Institute and as director of the Language Technology PhD program. He was one of the founding members of CMU's Human Computer Interaction Institute and serves on its core faculty.

He was one of the founders of C-STAR, the international consortium for speech translation research, and served as its chairman from 1998 to 2000. He also codirected Verbmobil, the German national speech translation initiative. His work on time delay neural networks was awarded the IEEE Best Paper award in 1990, and his work on speech translation systems received the Alcatel SEL Research Prize for Technical Communication in 1994. He received a BS in electrical engineering from the Massachusetts Institute of Technology in 1979, and M. and PhD degrees in computer science from Carnegie Mellon University in 1980 and 1986.

Andrew Glassner
Andrew Glassner is a novelist, screenwriter, and consultant in computer graphics. He began working in computer graphics in 1978, and has carried out research in the field at the New York Institute of Technology's Computer Graphics Lab, Case Western Reserve University, the IBM T.J. Watson Research Center, the Delft University of Technology, Bell Communications Research, Xerox PARC, and Microsoft Research. A popular writer and speaker, he has published numerous technical papers on topics ranging from digital sound to 3D rendering. His book 3D Computer Graphics: A Handbook for Artists and Designers has taught a generation of artists through two editions and three languages. He created and edited the "Graphics Gems" series and the book An Introduction to Ray Tracing. He wrote the two-volume text Principles of Digital Image Synthesis. His most recent book is Andrew Glassner's Notebook, a collection of the first three years of his regular column by the same name in IEEE Computer Graphics & Applications. He has served as Papers chair for SIGGRAPH 94, founding editor of the Journal of Graphics Tools, and editor-in-chief of ACM Transactions on Graphics. He wrote and directed the short film "Chicken Crossing," which premiered at the SIGGRAPH 96 Electronic Theater, and designed the highly participatory game "Dead Air" for The Microsoft Network, where he wrote and directed the live-action pilot episode. He is currently at work on his second novel and consulting on computer graphics, storytelling, and story structure for the computer game and online entertainment industry. In his spare time, he paints, plays jazz piano, kayaks, and hikes. He holds a PhD in computer science from the University of North Carolina at Chapel Hill.

Monika Fleischmann–imk.gmd.de:8081/people/fleischmann.mhtml
Monika Fleischmann studied visual arts, theater, and computer graphics. Since 1992, she has been artistic director of the institute for media communication and since 1997, head of the MARS Exploratory Media Lab at the German National Research Center for Information Technology (GMD) outside Bonn. She also teaches at the Academy of Design in Zurich. Her work, always produced with her partner, Wolfgang Strauss, has been exhibited at the Centre Pompidou, the Museum for Design, the Museum of Modern Art (New York), and events such as the annual SIGGRAPH conference, Imagina, Art Futura, ISEA, and Ars Electronica. In 1992, her Home of the Brain was awarded wih the Golden Nica for interactive art at Ars Electronicaz. Her work ranges among art, science, and technology. In theoretical and practical studies, she explores the creative potential of computer technologies. Her main research topics are human computer interfaces combined with interactive virtual environments and perceptive processes.

Rosalind W. Picard
Rosalind W. Picard is founder and director of the Affective Computing Research Group at the Massachusetts Institute of Technology Media Laboratory. She holds a bachelors in electrical engineering from the Georgia Institute of Technology and masters and doctorate degrees in electrical engineering and computer science from MIT. The author of over 80 peer-reviewed scientific articles in pattern recognition, multidimensional signal modeling, computer vision, and human-computer interaction, she is internationally known for pioneering research on content-based video retrieval and on giving computers the ability to recognize and respond to human emotional information. She is co-recipient with Tom Minka of a "best paper" award (1998) from the Pattern Recognition Society for their work on interactive machine learning with a society of models. Her award-winning book, Affective Computing (MIT Press, 1997), lays the groundwork for giving machines the skills of emotional intelligence. Her group's research on affective and wearable technologies has been featured in national and international public forums such as *The New York Times, The London Independent, Scientific American Frontiers, Time, New Scientist, Vogue,* and PBS and BBC specials.

2001 in 2001: How a Completely Analog Film Inspired a Digital Revolution

Panelists
Syd Mead
Peter Hyams
Robert Abel
Dennis Muren

Moderator
Jacquelyn Ford Morie

In 1968, Stanley Kubrick transformed Arthur C. Clarke's science-fiction story into an intriguing genre film and, in the process, made history. Awarded the 1969 Academy Award for Achievement in Visual Effects, "2001: A Space Odyssey" defined the future and our place in it. The film created a new perspective of the world and inspired a generation of artists, scientists, and filmmakers to look beyond the limitations of things they know and tools they know how to use.

It has been five decades since humans first left the earth, and just about that long since John Whitney used an analog computer to bring life to ephemeral images. In that time, we have traveled into space and far beyond the reaches of our imaginations to create incredible visions of the distant past and the unimagined future.

This session brings together a stellar group of film industry veterans, historians, and visionaries to discuss Kubrick's "2001: A Space Odyssey." They take us on a stimulating journey through the film and beyond, showing how its influence extends far beyond the reaches of film, space, and time.

Syd Mead
Designer and visual futurist of such films as "Tron," "2010," and "Blade Runner."

Peter Hyams
Director, writer, and cinematographer, whose work includes "2010," "Timecop," and "End of Days."

Robert Abel
Pioneering computer graphicist whose work defined an industry.

Dennis Muren
Visual effects creator for "Star Wars," "The Abyss," "Jurassic Park," "The Phantom Menace," and "AI."

Jacquelyn Ford Morie
Pioneering computer graphicist and artist who is currently destgning the future at the Institute for Creative Technologies.